August 25 2006

Mr. Devender Narala
Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

RE: Redlined Recommended Final Corrective Action Plan; Building 207/231 Area Presidio of San Francisco, California

Dear Mr. Narala:

The Presidio Trust (Trust) is pleased to provide the enclosed copy of the *Redlined Recommended Final Corrective Action Plan, Building 207/231 Area, Presidio of San Francisco, California*, dated August 24, 2006 for your review and concurrence. Upon California Regional Water Quality Control Board (Water Board) concurrence on the enclosed document, the Trust will submit the final CAP (without redlines) for official Water Board approval.

The Trust's original draft CAP for the Blg 207/231 Area site was dated July 15, 2005. The Water Board commented on the Draft CAP by letter dated June 15, 2006. The enclosed recommended final CAP is presented in redlined format so changes from the Draft CAP are readily apparent. The enclosed text, and plates of the CAP have been reproduced in their entirety, but only revised appendices, and Tables 3 through 7 are being provided for your review since there were no changes to Tables 1 and 2. The Draft CAP has been revised to:

1. Respond to Water Board comments on the Draft CAP;
2. Include results of the Evaluation of Arsenic in Groundwater Technical Memorandum, dated June 22, 2006
3. Include results of the Subsurface Geoarchaeological Survey, Building 207/231 Area, currently undergoing report finalization
4. Include recent updates to the Presidio Trust Land Use Control Master Reference Report.

This submittal includes the following:

- Revised text and Tables 3 through 7– changes are shown in tracked changes (redline-strikeout)
- Revised Plates have been included in their entirety.
- Appendix A – has not been included, but a CD of the soil and ground water tables will be provided in the Final CAP
- Appendix B, Cost Estimate and Revised Assumptions includes a Cost Estimate Summary Table that shows changes in total costs in red font to reflect updated unit costs from Tables B-1 through B-15 based on current Trust updated unit costs. However, because the majority of line items were revised, the changes are not shown

in redline on Tables B-1 through B-15. These tables have been revised in redline to show a newly-added assumptions column.

- Appendix C contains a Responsiveness Summary which is a first-time submittal to the Water Board for this document.

Once we receive Water Board concurrence on the enclosed recommended Final CAP, the Trust will submit the final CAP (without redlines) for official Water Board approval.

Please contact me at (415) 561-4259 if you have any questions.

Sincerely yours,
The Presidio Trust

Craig Cooper
Remediation Program Manager

Enclosure

cc Brian Ullensvang, National Park Service (NPS)
Bob Boggs, Department of Toxic Substances Control (DTSC)
Doug Kern, Restoration Advisory Board (RAB)
Mark Youngkin, RAB [Without Enclosure]

~~Revised Draft~~Redlined Recommended Final

Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Prepared for

The Presidio Trust
1750 Lincoln Blvd., P.O. Box 29052
San Francisco, California 94129-0052

MACTEC Project No. 4089041001 106

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August 24, 2006

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~~Revised Draft~~ Redlined Recommended Final
Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco
San Francisco, California

MACTEC Project No. 4089041001 106

This document was prepared by MACTEC Engineering and Consulting, Inc. (MACTEC) at the direction of the Presidio Trust (Trust) for the sole use of the Trust, the National Park Service (NPS), and regulatory agencies, the only intended beneficiaries of this work. No other party should rely on the information contained herein without the prior written consent of the Trust. This report and the interpretations, conclusions, and recommendations contained within are based in part on information presented in other documents that are cited in the text and listed in the references. Therefore, this report is subject to the limitations and qualifications presented in the referenced documents.

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~~SELECTED~~ TABLES

PLATES

APPENDIXES

DISTRIBUTION

ACRONYMS AND ABBREVIATIONS

Army	United States Department of the Army
ASC	Anthropological Studies Center, Sonoma State University
AST	aboveground storage tank
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CAP	Corrective Action Plan
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
CPT	cone penetrometer
cy	cubic yards
D&M	Dames & Moore
1,2-DCA	1,2-dicholoroethane
1,2-DCB	1,2-dicholorobenzene
1,4-DCB	1,4-dicholorobenzene
4,4’-DDD	4,4’-dichlorodiphenyldichloroethane (breakdown product of DDT)
ECC	Environmental Chemical Corporation
EKI	Erler & Kalinowski, Inc.
FDS	fuel distribution system
ft/ft	feet per foot
GGNRA	Golden Gate National Recreation Area
IT	IT Corporation
LTTD	low temperature thermal desorption
LUC	land use control
MACTEC	MACTEC Engineering and Consulting, Inc.
MCL	Maximum Contaminant Level
MeCl	methylene chloride
MTBE	methyl tertiary butyl ether
MW	Montgomery Watson
NPS	National Park Service
ORC®	Oxygen Release Compound®
ORP	oxidation-reduction potential
Order	RWQCB Order No. R2-2003-0080
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
PLLW	Presidio Lower-Low Water Vertical Datum of 1907
POCC	point-of-compliance concentrations
RAB	Presidio Restoration Advisory Board
RAO	remedial action objective
Redox	oxidation-reduction potential
RI	remedial investigation
RU	remedial unit
RWQCB	Regional Water Quality Control Board
SCR	Site Cleanup Requirements
SI	site investigation
Site	Building 207/231 Area

SVOCs	semi-volatile organic compounds
T&R	Treadwell & Rollo
TCE	trichloroethene
THRC	Tennessee Hollow Riparian Corridor
TPH	total petroleum hydrocarbons
TPHg	total petroleum hydrocarbons as gasoline
TPHd	total petroleum hydrocarbons as diesel
TPHfo	total petroleum hydrocarbons as fuel oil
Trust	Presidio Trust
U.S.	United States
UST	underground storage tank
VOCs	volatile organic compounds

EXECUTIVE SUMMARY

This Corrective Action Plan (CAP) has been prepared to evaluate and select corrective action alternatives for soil and groundwater at the Building 207/231 Area at the Presidio of San Francisco, California (Site) where residual petroleum hydrocarbons and petroleum-related chemicals occur from past use of the Site by the Army for servicing and fueling vehicles. Under several prior investigations and cleanup actions conducted in portions of the Site, underground storage tanks and fuel lines were removed, and the majority of soils associated with these structures that were impacted with petroleum-related chemicals were removed. Additional investigations were then conducted to collect data to define the nature and extent of any remaining contamination at the Site.

Future plans for use of the Building 207/231 Area may include onsite restoration of the adjacent Crissy Marsh and freshwater Tennessee Hollow Riparian Corridor. In addition, there are plans to replace the Doyle Drive/Highway 101 overpass that extends into the northern portion of the Site, as well as continued use of existing buildings by tenants and preservation of historic structures.

This CAP summarizes data from all previous and current investigations conducted within the Site, identifies where residual contamination still occurs above cleanup levels, and evaluates, compares, and recommends corrective action alternatives for each area that are consistent with planned and potential reuses and pertinent studies being conducted in adjacent areas as follows.

Site-Specific Considerations

The following resources, potential future uses, and programmatic data issues for the Building 207/231 CAP Site were considered in the development of corrective action alternatives:

- Pre-Construction Archaeological Investigation of the Building 207/231 Area: ~~Prior to implementation of the selected corrective action alternatives, an investigation w~~as~~ill be performed~~ A subsurface geoarchaeological survey was conducted at the Site in January 2006 to assess

potential cultural and/or historic resources in this area prior to implementation of the selected corrective action alternatives. The results of the survey are summarized in this CAP, and presented in the *Subsurface Geoarchaeological Survey of the Building 207/231 Area, Presidio of San Francisco, City and County of San Francisco, California* (*ASC & MACTEC, 2006*)~~.~~. The objectives of the investigation included: (1) formulating an approach to assess resources that may be present by reviewing pre-existing data (e.g., core samples, boring logs, cross-section profiles); (2) establishing a stratigraphy (i.e., a relationship between fill and native materials) in the areas of proposed impact (e.g., excavation areas); (3) preparing a Work Plan (*ASC, 2005*) for performing an archaeological field investigation that includes protocols and procedures to be followed in the event archaeological resources are encountered and to process archaeological findings that may be present within contaminated materials; and (4) conducting a field investigation with the intent of identifying historic, prehistoric, and historic structural features in the proposed impact areas by collecting information from trenches located in probable areas of sensitivity (*ASC & MACTEC; 2006*).

- Cultural and Historic Resources: Potential impacts to cultural and historic resources that are known to be or may be present within these remedial units (RUs) during implementation of corrective action alternatives would be minimized by (1) conducting the~~a~~ pre-construction geoarchaeological survey~~investigation~~; (2) requiring archaeological monitoring during intrusive activities to prevent adverse impacts; and (3) developing and recommending corrective action alternatives for RUs with identified historic resources that would not adversely affect their integrity (e.g., capping instead of excavation).

- Potential Crissy Marsh and Tennessee Hollow Riparian Corridor Expansions: Cleanup levels protective of these potential future uses as well as current uses were developed and used to define remedial units and corrective action alternatives. In addition, a range of backfilling options that would accommodate current and potential future uses were developed and costed for each RU as

appropriate, and include: (A) Backfill Option A—Open excavation with semi-permanent drainage system to prevent overflow with stabilization/restoration of the excavation area and replacement of existing roadways as necessary; (B) Backfill Option B—Partial backfill of excavation to above water table and stabilization with materials (such as sand and dune grasses) compatible with future restoration and replacement of existing roadways as necessary; (C) Backfill Option C—Complete backfill of excavation and restoration of site to match existing grade and conditions and replacement of existing roadways as necessary.

- Replacement of the Doyle Drive/Highway 101 Overpass: Corrective actions to remediate contamination and replace roadways and associated structures under existing site conditions were considered, as well as for the potential Doyle Drive replacement alternatives.

- Replacement of Gorgas Avenue Roadway Section: Corrective actions to remediate contamination beneath a section of Gorgas Avenue and then replace the roadway were included in the alternatives. However, replacement of this section of the Gorgas Avenue roadway would only be implemented if it were determined to be consistent with future restoration and development plans for this area.

- Arsenic in Groundwater: In 2006, the Trust conducted a study to further evaluate the presence of arsenic in groundwater and its relationship to petroleum hydrocarbons, soil types, and groundwater chemistry at the Building 207/231 Area, and two neighboring CAP sites—the Building 1065 Area and the Commissary/PX Area. The results of this study were presented in the *Technical Memorandum, Evaluation of Arsenic and Other Metals in Groundwater at Three Corrective Action Plan Sites, Presidio of San Francisco* (Arsenic in Groundwater Tech Memo; *MACTEC, 2006*), and considered in the development of corrective actions for groundwater contamination at the Site. Based on results of the study, arsenic is believed to be present in groundwater at elevated concentrations at these sites primarily due to degradation of petroleum

hydrocarbons in saturated soils at or downgradient of a petroleum hydrocarbon release (e.g., from former petroleum storage and distribution facilities at the Building 207/231 Area). It appears that arsenic is being mobilized from its adsorbed state on the iron coatings of soil particles due to more strongly reducing conditions imposed by the biodegradation of petroleum hydrocarbons present in saturated soils where petroleum releases occurred. To a lesser degree, arsenic may tend to mobilize into shallow groundwater due to locally reducing conditions caused by degradation of organic matter in the underlying Bay Mud. In addition, once the arsenic dissolves into groundwater, arsenic concentrations remain relatively stable over time. When the petroleum source and reducing conditions abate, arsenic concentrations may tend to slowly decrease due to dilution, dispersion, and transport.

~~Review of the arsenic data in groundwater at this and other adjacent sites suggest that it is correlated with reducing conditions that are influenced by a combination of factors. The presence of organic material in the underlying Bay Mud and/or the degradation of petroleum hydrocarbons may reduce the oxidation state of arsenic present in saturated materials, resulting in levels of arsenic present in groundwater above cleanup levels. Arsenic in groundwater and associated redox parameters (indicators of reducing conditions) will be included in the proposed corrective action alternative monitoring program for purposes of further evaluation consistent with the adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2005; T&R, 2004*).~~

The following sections summarize the results of the CAP for this Site.

Site History and Planned Land Use

The Site comprises approximately 8 acres of land located in the northeast portion of the Presidio of San Francisco, adjacent to the Crissy Marsh and bisected by the Doyle Drive/Highway 101 overpasses. In the prehistoric period, the Site originally comprised a large estuary of saltwater marshes and sloughs, as well as a freshwater lagoon. The Tennessee Hollow Riparian Corridor flowed northward, bisecting the Site

and draining into the marsh. Archaeological artifacts or cultural resources, such as middens and gravesites, have been identified in the surrounding area. The majority of this marsh and slough system has been filled in with soils and other materials over time in order to expand the usable land surface of the area.

In recent times, the Site was primarily used by the Army for servicing and fueling vehicles, and contained two service/gas stations. In addition, the Site had garages, a dry cleaning facility that used Stoddard solvent (petroleum hydrocarbon distillate), and fuel oil distribution lines. The garages, underground storage tanks (USTs), and fuel lines have since been removed and the Site currently consists of buildings, paved parking areas, roadways, and some landscaping.

Potential planned uses of the Building 207/231 Area may include the extension of Crissy Marsh adjacent to an historic wall located between Buildings 231 and 228; the restoration of the freshwater Tennessee Hollow Riparian Corridor; and replacement of the Doyle Drive/Highway 101 overpasses, now nearing the end of their useful lifespan. Buildings 228, 229, and the historic wall are designated for preservation as historic resources. The corrective action alternatives developed in this CAP consider these resources and potential planned land uses for the Site.

Previous Investigations and Corrective Actions

Previous investigations conducted by the Army consisted of a Preliminary Assessment, Site Investigation, Remedial Investigation (RI), and a previous CAP. The Trust conducted additional site characterization investigations to address data gaps identified from review of results of previous investigations (Data Gaps Investigation; *MACTEC, 2004 a, b*), and has been conducting a quarterly groundwater monitoring program at the Site. Previous corrective actions included removal and over-excavation of underground storage tanks (USTs), hydraulic lifts, and a fuel distribution system (FDS) line. Previous corrective actions included the following:

- Removal of USTs from or associated with Buildings 207, 228, and 231;
- Removal of FDS Line to Building 228; and
- Removal of Sump from Building 208.

Data from these investigations, the pre-construction subsurface geoarchaeological survey conducted in January 2006, and previous corrective actions were incorporated into the Trust's interpretation of site geologic and hydrogeologic conditions and the nature and extent of chemicals in soil and groundwater.

Geologic and Hydrogeologic Conditions

Previous investigations indicate the main water-bearing zones in the Building 207/231 Area are the shallow, upper intermediate, and lower intermediate zones. These three relatively permeable, sandy, water-bearing zones are typically separated from one another by two horizons of less permeable, clayey, fine-grained estuarine deposits (Bay Mud) observed across the Crissy Field Groundwater Area. The fine-grained estuarine deposits appear to pinch out south of Building 229, where Quaternary sedimentary deposits (including Pleistocene Colma Formation [older marine sands]) and Quaternary stream deposits are encountered at elevations above high sea level stands in San Francisco Bay. The shallow groundwater zone consists of saturated portions of the fill and, where present, the shallow sand. Groundwater in the shallow groundwater zone occurs under unconfined conditions and groundwater flow is to the north-northwest. The intermediate groundwater zone consists of the upper intermediate sand and lower intermediate sand. Groundwater in the intermediate zone is semiconfined and groundwater flow is generally to the north. Vertical gradients between the intermediate and shallow groundwater zones are consistently upward.

Based on review of the results of the subsurface geoarchaeological survey of the site conducted in January 2006, the subsurface geology within the nine trenches excavated at the Site was consistent with data from previous investigations, and consisted of varying strata of fill, sands, silts, and clays, with some

discontinuous occurrences of gravel fill containing anthropogenic material *(ASC & MACTEC, 2006)*. The lower strata of the trenches contained evidence of native soil in the form of gray fat clay, dark gray, brown, and black poorly-graded sand, and light yellowish brown poorly-graded sand. The gray fat clay typical of Bay Mud deposits was generally discontinuous at the depths excavated within the trenches.

Nature and Extent of Chemicals in Soil and Groundwater

Data from previous investigations were evaluated with respect to applicable cleanup levels to identify areas where chemicals were present at concentrations that could potentially pose a risk to human health, the environment, or drinking water quality. Based on this review, there are five general areas where chemicals are present above cleanup levels – (1) former Building 207 fueling station and adjacent former Building 208 in the northern portion of the Site; (2) former Building 38, 38-A, and garage oil station in the northeastern portion of the Site; (3) former Building 231 service station complex in the central part of the Site; (4) former Building 228 Stoddard solvent USTs in the southern part of the Site; and (5) a former railroad spur loading dock adjacent to Building 230 in the eastern portion of the Site.

- The former Building 207 area contained three former gasoline USTs and one former sump that have released chemicals to soil and groundwater. Chemicals released to soil at concentrations above cleanup levels include TPH as gasoline, diesel, and fuel oil (TPHg, TPHd, TPHfo); and benzene, toluene, ethylbenzene, xylenes (BTEX), lead, and methyl tertiary butyl ether (MTBE). Soil at the former Sump 208 also had benzo(a)pyrene, zinc, and lead at concentrations above cleanup levels. Chemicals released to groundwater at concentrations above cleanup levels at the former Building 207~~38~~ Area include TPHg, benzene, and MTBE. Groundwater at the former Sump 208 had the polynuclear aromatic compounds (PAHs) benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene at concentrations above cleanup levels.

- The former Building 38 area contained an oil station and a gasoline station that released chemicals to soil and groundwater. No records of specific uses or storage tanks are known to exist. Chemicals released to soil at concentrations above cleanup levels include TPHd, TPHfo, the metals arsenic, lead, and zinc, and the PAHs anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene. Chemicals released to groundwater at concentrations above cleanup levels include vinyl chloride, the metals arsenic and nickel, and the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene.

- The former Building 231 service station area contained four former gasoline, one former waste oil, and six former hydraulic lift USTs that have released petroleum hydrocarbons and petroleum related chemicals to soil and groundwater. The releases from these USTs have combined into one affected area. Chemicals released to soil at concentrations above cleanup levels include TPHg, TPHd, TPHfo, BTEX; the PAHs benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, the polychlorinated biphenyl (PCB) Arochlor 1016; the volatile organic compounds (VOCs) tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride (VC), methylene chloride (MeCl); the pesticide 4,4'-DDD; and the metals arsenic, chromium, cobalt, copper, lead, mercury, nickel, silver, and zinc. Chemicals released to groundwater at concentrations above cleanup levels include TPHg, TPHd, TPHfo, BTEX, PCE, TCE, 1,2-dichlorobromene, the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, and chrysene; the PCB Arochlor 1016, and the metals arsenic, nickel, lead, vanadium, and zinc.

- The Building 228 area contained three former Stoddard solvent USTs that released Stoddard solvent (a petroleum distillate in the TPHg, TPHd, TPHfo range) to soil and groundwater, as well

as ethylbenzene and xylenes in soil; 1,2-dichlorobenzene (1,2-DCB) and nickel were also detected in groundwater at concentrations above cleanup levels.

- The Building 230 area contained a railroad spur and loading dock along the east side of the building. Chemicals released to soil at concentrations above cleanup levels include TPHd, TPHfo, lead, and the PAHs acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, and pyrene. Groundwater was not sampled in this area; however, saturated soils were sampled at intervals of 7.5 and 10 feet bgs, and no COCs were detected above cleanup levels.

- The former Building 271 area contained a garage at the north end of the building. Chemicals released to soil at concentrations above cleanup levels include benzo(a)pyrene, lead, and zinc. Chemicals released to groundwater at concentrations above cleanup levels include the PAHs benzo(a)anthracene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, and chrysene.

Chemicals of Concern

Based on the occurrence and concentrations of chemicals in soil and groundwater at concentrations exceeding cleanup levels, the following chemicals of concern (COCs) were identified for cleanup in soil:

- Petroleum hydrocarbons – TPH as gasoline, diesel, fuel oil;

- VOCs – BTEX, MTBE, PCE, TCE, bromobenzene, VC, MeCl, 4,4'-DDD;

- PAHs – acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, pyrene;

- Metals – arsenic, chromium, cobalt, copper, lead, mercury, silver, and zinc; and

- PCBs – Arochlor 1016.

The following COCs were identified for groundwater:

- Petroleum hydrocarbons TPH as gasoline, diesel, fuel oil;
- VOCs - BTEX, MTBE, PCE, TCE, 1-2,DCA, VC, bromobenzene;
- PAHs - benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene;
- PCBs – Arochlor 1016; and
- Metals arsenic, lead, nickel, vanadium, and zinc.

Although MeCl was detected above cleanup levels in groundwater at the Site, MeCl was not retained as a COC. MeCl is a common laboratory contaminant and its detection is considered suspect and unreliable. ~~Arsenic was retained as a COC because it may be present as a result of local reducing conditions in groundwater caused by the presence of Bay Mud or degradation of petroleum hydrocarbons. The degradation of petroleum hydrocarbons in the vicinity of the former USTs may have contributed to reducing conditions and locally increased arsenic solubility in groundwater. The source of arsenic is likely from native sand or fill material overlying the Bay Mud. When TPH is cleaned up, the reducing conditions may be reversed and concentrations of dissolved arsenic decline.~~

Remedial Units

Cleanup levels were developed for soil and groundwater using the most stringent (lowest) of four different receptor scenarios: (1) Protection of Human Health, Residential Use; (2) Protection of Ecological Receptors, Buffer-Zone/Special Status; (3) Protection of Saltwater Ecological Receptors; and (4) Protection of Freshwater Ecological Receptors. Based on occurrences of COCs exceeding the cleanup levels in soil and groundwater at the Site, five remedial units (RUs or areas of contamination exceeding cleanup levels) were identified, comprising seven areas of petroleum-related soil contamination and four

areas of groundwater contamination. Arsenic and other metals were detected in groundwater above cleanup levels at isolated locations. Based on review of available groundwater monitoring data collected during the four ~~most recent~~ quarterly monitoring events in 2004 (First Quarter 2004; Second Quarter 2004; Third Quarter 2004; Fourth Quarter 2004), arsenic exceeded its cleanup level of 10 µg/L in several monitoring locations (*T&R, 2005*). As described in the Arsenic in Groundwater Tech Memo (*MACTEC, 2006*), elevated dissolved arsenic concentrations in shallow groundwater are likely the result of geochemical changes caused by locally reducing conditions from degradation of organic matter in the underlying Bay Mud and degradation of petroleum hydrocarbons. Therefore, although no formal arsenic groundwater remedial unit has been established for the Site, groundwater monitoring for arsenic and associated parameters is included in the corrective actions for the Site.

~~Review of the arsenic data suggest that it is correlated with reducing conditions that are influenced by a combination of the organic material in the underlying Bay Mud and/or the degradation of petroleum hydrocarbons and a source of arsenic in saturated materials. Therefore, arsenic in groundwater and associated redox parameters (indicators of reducing conditions) will be analyzed under the proposed corrective action alternative monitoring program for purposes of further evaluation consistent with the adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2005; T&R, 2004*)~~.

Former Building 207 Area (Including Former Building 208 Sump) — Two areas of soil contamination in this area are co-located with an area of groundwater contamination associated with the former Building 207 USTs as follows:

Soil

Three subareas of soil with chemicals above cleanup levels are present along the edges of the previous 1996 and 1998 excavations, and an additional adjacent area associated with the former Building 208 sump. In addition, the 1996 excavation was backfilled with LTTD soil that contains COCs above cleanup levels consistent with the saltwater and freshwater protection zones evaluated for the Site. The combined

soil subareas, the area of LTTD backfill, and the former Building 208 sump area comprise the approximately 1,130 cubic yards of soil within this RU. The majority of soil containing COCs above cleanup levels is located in the vadose zone from 3 to 3.5 feet bgs associated with the Building 207 Area, and comprises approximately 1,100 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels in this location include:

- TPHs – TPH as gasoline, diesel, and fuel oil;
- BTEX and MTBE; and
- Metals – lead.

Soil containing COCs above cleanup levels associated with the former Building 208 sump is located in saturated soil from 5 to 7.5 feet bgs, and comprises approximately 30 cubic yards of soil. The COCs that were detected above cleanup levels in this location include:

- TPHs – TPHg, TPHd, TPHfo, and Unknown TPH;
- PAHs – benzo(a)pyrene; and
- Metals – lead and zinc.

Groundwater

The COCs that were detected in groundwater at concentrations above cleanup levels at this area occur in the shallow aquifer at depths ranging from 7 to 16 bgs, and include:

- TPHs – TPH as gasoline;
- Benzene and MTBE; and

- PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene.

Former Building 38, 38-A, Garage Area — The soil RU at this area is co-located with a groundwater RU associated with use of the former Building 38, 38-A and garage areas.

Soil

The soil RU is located beneath and around the former garage in unsaturated and saturated zone soils between 0.5 and 10 feet bgs, and comprises approximately 670 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels include:

- TPHs – TPH as diesel and fuel oil;
- PAHs – anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene; and
- Metals – arsenic, lead, and zinc.

Groundwater

The co-located shallow groundwater RU occurs at depths ranging from 10.5 to 12 feet bgs, and encompasses the former Building 38 garage, 38-A, and the southeast portion of former Building 38. The COCs that were detected in groundwater at concentrations above cleanup levels include:

- VOCs – vinyl chloride;
- PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene; and
- Metals – arsenic and nickel.

<u>Existing Building 231 Area</u> —The soil RU at this area is co-located with a groundwater RU associated with the former Building 231 USTs.

<u>Soil</u>

The soil RU is located from north of the historic wall to below the Southern Doyle Drive/Highway 101 Overpass, east of Halleck Street, and west of Building 230, encompassing Building 231, ~~, and~~ the former locations of the USTs associated with Building 231, and the adjacent Former Building 271 garage area described below. The extent of chemicals in soil extending north of the Southern Doyle Drive/Highway 101 Overpass and south of former Building 207 has not been fully characterized due to the presence of footings for pilings and cross-braces that limited access beneath the overpass. As a result, the northern extent of the area is not known. The soil RU is located in unsaturated and saturated zone soils between 0.5 to 10 feet bgs, and comprises approximately 7,200~~190~~ cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels include:

- TPHs – TPH in the ranges of gasoline, diesel, and fuel oil;
- VOCs – BTEX, MeCl, PCE, and vinyl chloride;
- PAHs – benzo(a)pyrene, benzo(b)fluoranthene, and benzo(b+k)fluoranthene;
- Metals – arsenic, chromium, cobalt, copper, lead, mercury, nickel, silver, and zinc; and
- Pesticides and PCBs – 4,4'-DDD and Arochlor 1016.

<u>Groundwater</u>

A co-located shallow groundwater RU occurring at depths ranging from 8 to 24 feet bgs is located from north of the historic wall to below the Southern Doyle Drive/Highway 101 Overpass, east of Halleck Street, and east of Building 231 and the former Building 231. ~~Current groundwater conditions~~ Due to technical constraints associated with siting and operating investigation equipment near existing roadway

structures below the Southern Doyle Drive/Highway 101 Overpass,~~-~~ current groundwater conditions in~~are not known, so~~ the northern portion~~extent~~ of this area are~~is not~~ unknown, and will be assessed in coordination with the Doyle Drive reconstruction efforts. The COCs that were detected in groundwater at concentration above cleanup levels include:

- TPHs – TPH in the ranges of gasoline, diesel, and fuel oil;
- VOCs – BTEX, bromobenzene, 1,2-DCA, PCE, and TCE;
- PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, and chrysene;
- Metals – arsenic, lead, nickel, vanadium, and zinc; and
- PCBs – Arochlor 1016.

Existing Building 228 Area — The soil RU at this area is co-located with a groundwater RU associated with the former Building 228 USTs.

Soil

The areas of soil containing COCs above cleanup levels are located between historic Building 228 and the historic wall within the excavation associated with the former 228 USTs, and just south of Building 228 within an area that formerly contained a fuel distribution system (FDS) line. The northern soil RU is located in unsaturated and saturated soil between 1 to 11 feet bgs, and comprises approximately 120 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels include:

- TPH as gasoline, diesel, and fuel oil;
- Ethylbenzene, xylenes, and PCE;
- Arsenic, lead, and nickel.

The southern soil RU is located immediately south of Building 228 within the former excavation associated with the FDS lines located in vadose zone soil at 6 feet bgs, and comprises approximately 30 cubic yards of soil which is located immediately adjacent to and beneath the south side of the historic Building 228. The COCs that were detected in soil at concentrations above cleanup levels include:

- TPH as diesel and fuel oil.

Groundwater

The co-located shallow groundwater RU occurs at a depth of 16 ft bgs, and extends from north of Building 228 to south of the historic wall, within the excavation associated with the former 228 USTs. The COCs that were detected in groundwater at concentrations above cleanup levels include:

- TPHs – TPH as gasoline, diesel, and fuel oil;
- VOCs – 1,2-DCB; and
- Metals – nickel.

Existing Building 230 Loading Dock — The Soil RU at this area is associated with railroad activities conducted east of existing Building 230, which includes a portion of the railroad spur.

Soil

COCs above cleanup levels occur in vadose zone soils between 3 to 5.5 feet bgs adjacent to and just east of the building, and comprise approximately 400 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels include:

- TPHs – TPH as diesel and fuel oil;
- PAHs – acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, and pyrene; and

- Metals – lead.

Groundwater

Groundwater was not sampled in this area; however, saturated soils were sampled at intervals of 7.5 and 10 feet bgs, and no COCs were detected above cleanup levels within saturated soil samples. Therefore, this is the only soil RU at the Site that is not co-located with an identified Groundwater RU. However, because groundwater has not been sampled within this RU to verify there have been no impacts from COCs in soil, the corrective action alternatives for the Building 230 RU will include groundwater sampling and monitoring as under the other RUs with known contamination.

Former Building 271 Area (To be Addressed under Building 231 Area)— The former Building 271 area contained a garage at the north end of the building. This area contains one location where COCs were detected in soil and groundwater slightly above cleanup levels that will be addressed in conjunction with the portion of the adjacent Building 231 Area that also extends under the Doyle Drive Overpass that will be reconstructed.

Soil

The chemicals detected at the former Building 271 Area that exceeded cleanup levels in soil included the PAH benzo(a)pyrene, and the metals lead, and zinc.

Groundwater

The chemicals detected at the former Building 271 Area that exceeded cleanup levels in groundwater included the PAHs benzo(a)anthracene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, and chrysene.

~~Recommended~~Selected Corrective Actions

Potential remedial technologies were screened based on their effectiveness implementability and relative costs in treating the COCs identified in soil and groundwater at the Site. The potential remedial technologies that were considered in the screening include:

- No action;
- Land use controls;
- Capping;
- In situ soil and groundwater treatment;
- Extraction and ex situ groundwater treatment;
- Excavation of soil with ex situ soil treatment; and
- Excavation of soil with offsite disposal.

The remedial technology screening focused on petroleum-related COCs present within the RUs (e.g., TPH, VOCs) that are the primary COCs in terms of their distribution and frequency of detection. Based on this screening, the following corrective action alternatives were retained for further consideration with respect to cleanup of the identified RUs:

1. No Action;
2. Capping, Land Use Controls, and Groundwater Monitoring; or
3. Excavation, Offsite Disposal of Soil, and Groundwater Monitoring.

~~Recommended~~Selected alternatives for each of the RUs are summarized below. Corrective actions selected are those that are protective of human health, the environment, groundwater quality, are cost-

effective, allow reuse of the Presidio under the Presidio Trust Management Plan, and meet Site Cleanup Requirements under RWQCB Order No. R2-2003-0080.

~~Recommended~~Selected Corrective Action Alternative for All RUs Except Historic Building 228 Area—Alternative 3, Excavation, Offsite Disposal of Soil, and Groundwater Monitoring.

Alternative 3 involves excavation and removal of all contaminated soil where COCs are present above cleanup levels from Soil RUs (except under existing buildings or structures designated for preservation), followed by waste characterization, transport to, and disposal of waste materials at an approved offsite disposal facility. Because the Site is in the vicinity of archaeologically sensitive areas, work at this Site would be monitored for cultural resources. During excavation, confirmation samples would be collected from the excavation floor and sidewalls to verify that soils exceeding cleanup criteria have been removed; remedial decisions will be based on petroleum-related COCs. Backfilling excavations and restoring the area for its intended reuse would be implemented via one of three options to provide flexibility in planning for future restoration of the Crissy Marsh that may extend into the Site: (A) *Backfill Option A*: Open excavation with semi-permanent drainage system to prevent overflow with stabilization/restoration of the excavation area and replacement of existing roadways as necessary; (B) *Backfill Option B*: Partial backfill of excavation to above water table and stabilization with materials compatible with future restoration and replacement of existing roadways as necessary and installation of semi-permanent drainage system; (C) *Backfill Option C*: Complete backfill of excavation and restoration of Site to match existing grade and conditions and replacement of existing roadways, as necessary.

The need for (1) application of oxygen release product as a contingency via in situ injection and/or (2) implementation of interim land use conditions (LUCs) will be performed if groundwater monitoring data indicates the excavation of source materials did not reduce groundwater COCs below cleanup levels will also be assessed. Details regarding the need for, implementation, and duration of these contingencies

would be described in a supplemental report based on the results of post-construction groundwater monitoring.

This alternative also includes monitoring of a network of upgradient, crossgradient, and downgradient wells for COCs and the eventual abandonment of these wells upon regulatory approval. Monitoring would be conducted to verify that chemical concentrations are decreasing and that chemicals in groundwater are not migrating offsite until the point in time when all COCs have been consistently below cleanup levels for four consecutive monitoring events. For the purposes of preparing cost estimates for this alternative, it is assumed groundwater monitoring would be conducted quarterly during the first year, and semi-annually for an additional 2 years.

Excavation and removal of contaminated soil would be protective of human health, safety, and the environment, because the shallow soil contamination is removed, thereby eliminating potential human and ecological exposures to contaminants. The excavated soil would be transported offsite to a facility approved to manage the waste. This remedy is technically effective and permanent. Contaminated soil is removed, thereby preventing worker and visitor exposures and impacts to groundwater. Although the volume of contaminants will not be reduced because the impacted material will not be treated, potential exposure of workers and the public to contaminated materials during excavation and loading for offsite transport would be mitigated by engineering and dust control measures. This alternative is implementable and no significant obstacles have been identified except for portions of some of the RUs that extend beneath existing buildings or historic structures designated to be preserved or abutting such structures. For buildings that are not designated for preservation (Building 231), they will be demolished prior to excavation. For buildings and structures that are designated to be preserved, this alternative would not be applicable (Building 228 Area). Although the total costs for this alternative in some cases would be higher than for Alternative 2 (Capping, Land Use Controls, and Groundwater Monitoring), Alternative 3 is ~~recommended~~selected for all accessible RUs because:

- Effectiveness—Excavation and offsite disposal would mitigate risks, comply with environmental laws, and permanently remove soil and groundwater containing COCs above cleanup levels to provide eventual 'clean closure' after a period of groundwater monitoring to confirm COCs are below cleanup levels in groundwater. Complete removal of COCs would also allow for restoration and expansion of Crissy Marsh, the Tennessee Hollow Riparian Corridor, and Doyle Drive replacement roadways into the Site.

- Implementability—Excavation and offsite disposal would be implementable from an administrative perspective because it takes action to mitigate risks and comply with environmental laws. It would involve a high level of effort to implement from a technical perspective. However, the equipment and materials to implement this alternative are readily available.

- Cost—Excavation and offsite disposal has a moderate-to-high cost.

~~Recommended~~Selected Corrective Action Alternative for Historic Building 228 Area—Alternative 2, Capping, Land Use Controls, In Situ Groundwater Treatment, and Groundwater Monitoring.

Alternative 2 improves on, replaces as necessary, and maintains existing asphalt and concrete foundation caps over the Soil RU to isolate the contaminated soil from human exposure. Capping improvements would include inspections, indoor air quality monitoring, sealing indoor conduits or fractures in the building foundation to prevent volatile COCs from migrating into the building, and resealing or repaving the asphalt parking areas outside the building. For this historic building and adjacent historic wall that are designated to be preserved, this alternative would be consistent with the current and planned reuses of the building and parking areas. Because COCs above cleanup levels are not removed via capping, this alternative would include the development and implementation of LUCs to safeguard the cap; provide advance notice of site conditions in the event of future ground disturbing activity; and restrict future land uses to those compatible with safeguarding the integrity of the cap. For the purposes of preparing cost

estimates for this alternative, it is assumed cap inspection and maintenance would be performed on a yearly basis for a period of 30 years (the maximum time period for costing annual long-term operations and maintenance costs recommended by USEPA [*USEPA, 2000*]).

Because the Building 228 RU occurs directly upgradient of the Building 231 RU and the source of petroleum-related COCs would not be removed under this alternative and could potentially re-contaminate the Building 231 RU, a one-time in situ injection of an oxygen release product slurry on a closely-spaced grid using direct push technology within the saturated zone in this RU would also be ~~includ~~implemented. The effectiveness of the in situ injection of oxygen release product in reducing groundwater COCs below cleanup levels will be assessed (1) during groundwater monitoring of downgradient wells for COCs over a 2-year period following injection, and (2) after the 2-year period by collecting 10 in situ soil confirmation samples and 4 in situ groundwater confirmation samples using direct push technology. The need for additional injection or implementation of other technologies consistent with mitigating or preventing migration of groundwater containing COCs above cleanup levels will also be assessed. Details regarding the need for, implementation, and duration of these contingencies would be described in a supplemental report based on the results of post-injection groundwater monitoring and in situ soil and groundwater confirmation sampling. If follow-up groundwater monitoring and confirmation sampling ~~and groundwater monitoring~~ conducted 2 years after in situ injection determines this technology was effective in reducing COCs below cleanup levels, the LUC would be lifted.

This alternative also includes monitoring of downgradient wells for COCs and the eventual abandonment of these wells upon regulatory approval. Monitoring would be conducted annually to verify that chemical concentrations are decreasing and that chemicals in groundwater are not migrating offsite until the point in time when all COCs have been consistently below cleanup levels for four consecutive monitoring events. The monitoring duration and frequency would be assessed based on the results of the effectiveness of the in situ injection of oxygen release product in reducing groundwater COCs below

cleanup levels over a 2-year period following injection. For the purposes of preparing cost estimates for this alternative, it is assumed groundwater monitoring would be conducted annually for a period of 10 years.

Capping of contaminants would be protective of human health, safety, and the environment, as it would eliminate the potential for contaminant exposure through soil ingestion, dermal contact, and inhalation. LUCs would also prevent direct contact with the contaminated soil and future land uses that are not ~~in~~consistent with levels of contamination remaining onsite and establish procedures for the management of contaminated soil, if encountered in the future. This alternative is technically effective if caps are maintained and LUCs imposed. Groundwater monitoring would provide a long-term assessment of groundwater quality. Although no active treatment of soil would be performed, the potential for migration of COCs from soil into groundwater would be reduced based on the reduced potential for surface water infiltration provided by the cover. Capping with LUCs is readily implementable, particularly because the majority of the applicable Soil RU is already capped with asphalt and concrete (i.e., pavement and building foundations). Capping improvements (e.g., inspections, indoor air quality monitoring, resealing or repaving asphalt) would involve some design and construction improvements. Alternative 3 is ~~recommended~~selected for implementation at the Building 228 Area because:

- Effectiveness—Capping with land use controls would mitigate risks and comply with environmental laws, but would not permanently remove COCs to provide ‘clean closure’. However, this RU is covered by pavement and buildings, and there are no residential or ecological receptors using or planning to use this area, so this alternative would provide a low cost option for mitigating risks under current reuses until the time when/if the site reuses are modified.

- Implementability—Capping with land use controls would be implementable from an administrative perspective because caps and LUCs would be maintained and comply with environmental laws. Easy level of effort to implement from a technical perspective.

- Cost—Capping with land use controls has a ~~low-to-~~moderate cost.

1.0 INTRODUCTION

This Corrective Action Plan (CAP) has been prepared by MACTEC Engineering and Consulting, Inc. (MACTEC) on behalf of the Presidio Trust (Trust) to evaluate potential corrective action alternatives for the Building 207/231 Area (Site) at the Presidio of San Francisco, California (Plate 1). The following sections discuss the purpose and scope of the CAP, and summarize the report organization.

1.1 Purpose and Scope of CAP

The purpose of this CAP is to evaluate potential corrective action alternatives to address adverse effects related to releases of petroleum hydrocarbons and petroleum-related chemicals at the Site.

Prior to the transfer of authority for remediation at the Presidio from the Army to the Trust in 1999, the Army conducted various investigations and removal actions, as discussed in Section 3.3. The Army prepared a Draft Building 207/231 Area Corrective Action Plan in 1999 (*Montgomery Watson [MW] Draft CAP*, *1999b*). The MW Draft CAP considered most, but not all of the available previously-collected data and information. Based on the data and information used, the MW Draft CAP discussed the hydrogeology, and nature and extent of contamination at the Site. Corrective action objectives and action levels were developed that considered the protection of human health, water resources, and ecological receptors, as those issues were understood at that time. The MW Draft CAP presented a statistically-based decision analysis that attempted to incorporate stakeholder input into the decision-making process and statistically evaluate the input. A specific alternative was selected that proposed vadose zone soil excavation and groundwater remediation using an oxygen-releasing compound. However, the Army did not follow through with or use the statistically-derived decisions. In addition, the Draft MW CAP was viewed by stakeholders as incomplete and was not implemented.

Subsequently, the Trust conducted a data gaps investigation, in which available information and data was collected and evaluated for data gaps, and a data gaps investigation was conducted to fill the identified

data gaps in support of the preparation of this CAP. The scope of this CAP is to perform a thorough evaluation of all available data and a comprehensive development and analysis of corrective action alternatives.

Some of the potential corrective action alternatives to be considered may include intrusive activities. However, to the extent possible, the corrective action activities must be performed within the context of the protection of cultural resources and the implementation of planned land uses at the Site, as discussed below.

The Presidio, including the Building 207/231 Area being addressed in this CAP, has a long history of use that extends from prehistoric times through a period of military uses through to the present non-military mixed use. Archaeological artifacts or cultural resources, such as middens and gravesites, have been encountered at various locations throughout the Presidio, including locations near and within the area of the Site. As discussed in Section 2.2, the possibility of encountering cultural resources within the area of the Site is considered moderate to high. ~~Therefore,~~Although the results of the subsurface geoarchaeological survey conducted at the Site in January 2006 did not identify significant artifacts of archaeological research value (*ASC & MACTEC, 2006*), the corrective action alternatives considered in this CAP were developed assuming that cultural resources might be encountered during ground-disturbing (intrusive) activities and that monitoring and protective measures will need to be implemented to identify and protect those cultural resources, as required by the National Historic Preservation Act (*NHPA, 1996*).

The Presidio is currently being transformed from its previous military uses to a variety of non-military land uses. The planned land uses for the area within the Site are currently being developed and include the restoration of some areas within the Site to their original marsh habitat as part of the Crissy Marsh expansion, the restoration of the Tennessee Hollow Riparian Corridor (THRC) that historically passed through the Site, and the replacement of the Doyle Drive/Highway 101 overpasses, nearing the end of

their useful lifespan. Various alternatives for each of the above-listed planned land uses are currently being developed. The selection of final alternatives is unlikely to be complete before the submittal of this CAP. Therefore, the corrective action alternatives developed in this CAP considered all of the planned land use alternatives, as they are currently understood, as discussed in Section 2.3.

1.2 Report Organization

This CAP is organized into the following sections:

Section 1.0 – Introduction – The introductory section describes the purpose and scope of the CAP and lists the report organization. The introductory section also introduces the context under which corrective action alternatives must be performed including natural and cultural resources, and planned land uses.

Section 2.0 – Overview – This section describes the context under which this CAP was prepared. The context must be considered in the development of corrective action alternatives because the Site's natural and cultural resources must be protected and the corrective action alternatives must not conflict with future planned land uses. This section describes the Building 207/231 location and current physical description, the cultural resources and how the potential presence of those resources affects the corrective action alternatives, the planned land uses and site-specific considerations and how they affect and can be accommodated by the corrective action alternatives, the regulatory framework identifying the regulatory requirements to be fulfilled by this CAP, and the public participation in the preparation of this CAP.

Section 3.0 – Site Background – This section provides background information on the Site by summarizing the geology and hydrogeology, Site history, previous corrective actions and investigations, and describes the source, nature and extent of known contamination still present onsite. This information is used to present a conceptual site model.

Section 4.0 – Summary of Site Risks – This section summarizes the Remedial Action Objectives, development of cleanup levels based on human health and ecological concerns to be used for the

remediation of this Site, and identifies the soil and groundwater remedial units (areas where concentrations of chemicals of concern exceed cleanup levels).

Section 5.0 – Summary and Evaluation of Alternatives – This section describes the site-specific considerations; initial remedial technology screening criteria; identifies potential remedial technologies for soil and groundwater; describes technologies retained for further analysis and developed into corrective action alternatives; describes the evaluation criteria for the alternatives; and evaluates, compares, and ~~recommends~~ selects corrective action alternatives for each remedial unit evaluated.

Section 6.0 – Implementation of Corrective Action Alternatives – This section describes the tasks associated with implementation of the ~~recommended~~selected alternative(s).

Section 7.0 – References – This section lists the references cited in this CAP.

2.0 OVERVIEW

The following sections provide details on the Site location and physical description, the cultural resources and how the potential presence of those resources affects the corrective action alternatives, the planned land uses and how the planned land use alternatives may affect the corrective action alternatives, the regulatory framework identifying the regulatory requirements to be fulfilled by this CAP, and the public participation in the preparation of this CAP.

2.1 Site Location and Description

The Building 207/231 Area is an approximately 8-acre site generally bounded to the north by the Crissy Marsh and Vallejo Street, to the west by Building 204, to the south by the Building 223, and to the east by the parking area adjacent to Building 230 (Plate 1). The area gently slopes to the north with elevations ranging from approximately 10 to 25 feet above the Presidio lower-low water vertical datum (PLLW) (*IT, 1999a*). The Site consists of former and existing buildings, paved parking areas, roadways, the Doyle Drive/Highway 101 overpasses, and some landscaping. The Site includes the former or present locations of Buildings 38, 38A, 38 Garage, 119, 201, 202, 203, 206, 207, 208, 227, 228, 229, 231, 271, and the area just west of former Buildings 119 and 271; the buildings currently present on the Site are shown on Plate 2. The Site boundaries were established to include the buildings listed above, the fuel or oil underground storage tanks (USTs) and piping associated with those buildings, and the areas affected by releases from those USTs and piping.

The prehistoric, historic, and planned land uses for the Site are discussed in Sections 2.2 and 2.3. Details of individual building histories and uses are summarized in Section 3.2. As shown on Plates 1 and 2, the Site falls within freshwater and saltwater ecological protection zones. These area designations and the associated regulatory requirements are discussed in Section 2.5 - Regulatory Framework.

2.2 Site History

National Park Service (NPS) historians, archaeologists, and historical architects have developed a historical context for the Presidio in which periods of significance have been established based on activities and occupants *(Alley et al, 1993)*. These periods are as follows:

- Prehistoric Period (Pre-1776);
- Spanish-Mexican Settlement (1776-1846);
- Early United States Occupation (1846-1860);
- Civil War (1861-1865);
- Indian and Military Affairs (1866-1890);
- Nationalistic Expansion (1891-1914);
- World War I (1915-1918);
- Military Affairs between the Wars (1919-1940);
- World War II (1941-1945); and
- 1945 to the Present.

The prehistoric and historic site histories are summarized in the following sections with a focus on the cultural resources known to be present in and near the Site.

2.2.1 Prehistoric Period (Prior to 1776)

The prehistoric period extends to the 1770s, when Spanish explorers made initial contacts with the local Native Americans. Based on the studies at the Presidio (*J&S, 2001*), Native Americans occupied the former shoreline of a marsh and slough that extended inland from the current boundary of Crissy Marsh. The area originally consisted of a large estuary of saltwater marshes and sloughs, as well as a freshwater lagoon. Plate 3a shows the topographic elevations believed to exist as of approximately 1871, believed to be just prior to the beginning of the filling in of the marsh and slough (*1871 elevation contours provided*

by Ben Jones, Presidio Trust). The area with elevations of less than 6 feet included the marsh and slough system that drained to the east (*J&S, 2001*). Plate 3b shows the historic shoreline and fill locations in the years 1859, 1870, 1881, 1888, 1893, and 1902. A beach and high dune area, previously known as Strawberry Island, was formerly present along the current north shoreline of the current San Francisco Bay (*J&S, 2001*). The THRC is thought to have flowed northward and entered the marsh approximately between Buildings 231 and 230. The THRC is currently confined within a 72-inch diameter subsurface pipe that empties into Crissy Field Marsh. The location of the subsurface pipe is shown on Plate 3a.

Prehistoric finds near the Site are shown on Plate 3a and include two shell middens and an isolated human burial. One site where human remains were discovered is located approximately 500 meters west of the Site (CA-SFR-6 and CA-SFR-26). The other (CA-SFR-129) is located north of Mason Street adjacent to the Crissy wetlands *(J&S, 2001*). The SFR-6 location included fish, mammal, and bird remains, shell, charcoal, worked rock fragments, and other residue. The SFR-26 location included an isolated, buried, 25 to 30-year-old, female Native American, found with shells, plants, and a bird bone whistle fragment. The SFR-129 location included flaked and ground stone artifacts including one obsidian triangular serrate corner-notched projectile point, flake tools and hammerstones, shell beads, fire-cracked rock, shellfish, animal bones, charcoal, and plant seeds (*Clark and Ambro, 1999*).

The locations of the shellmounds are along both the backdune and bluff edges of the marsh. The original configuration of the marsh shows that within the area of the Site, the marsh shoreline would have been located in the area of Buildings 228, 229, 230, and 231 (Plates 3a and 3b). Considering that the marsh and slough configuration probably varied over time, it is possible that shellmounds and other prehistoric cultural resources might be present within proposed remedial units within Building 207/231 area. The former shoreline and confluence of THRC and the marsh may have been located between Buildings 230 and 231. This area may represent an area of significant prehistoric resources.

2.2.2 Historic Period (1760s – 1945)

The historic period began in the late 1760s to early 1770s, when Spanish explorers made initial contacts with the local Native Americans. The Spanish colonists were not interested in merely acquiring new lands but were intent on converting native peoples to Christianity. The impact on the Native Americans devastated their traditional culture as they were forced to adapt to the tenets of a new religion. By 1900, few native groups in the San Francisco Bay Area were living by traditional means that would have resulted in the prehistoric cultural resources described above *(J&S, 2001)*.

Until 1846, the Presidio was an outpost occupied by the Spanish, followed by the Mexicans, with minimal activity and no known structures within the area of the Site. The beach and dune areas, described above as Strawberry Island, were reportedly used for offshore anchorage. However, access to the anchorage would have been along pathways around the Site area, rather than through the marsh that occupied the Site at that time.

In 1850, the Presidio of San Francisco was designated a U.S. military reservation. The period for historical significance for the Army occupation is considered to be between 1850 until the end of World War II in 1945 *(J&S, 2001)*.

During the 1850s, new wooden barracks, a hospital, a guardhouse, a supply storehouse, and new stables were constructed. In addition, the Army filled in portions of the marsh and slough areas starting in at least the 1870s, with the greatest landfilling occurring between about 1895 and 1912. These remaining structures and the portions of the landfills in the slough and marsh are considered historical resources which both the Trust and the NPS are legally mandated to preserve in accordance with the National Historic Preservation Act of 1966 and the Archaeological Resources Protection Act of 1979.

As of 1896, the Quartermasters facilities and cavalry stables were documented to be present to the west of and extending into the Site and most of the marsh appears to still be present (*J&S, 2001*). The early

Quartermaster complex consisted of numerous buildings, including stables, storehouses, gun and wagon sheds, shops, blacksmith shops, and granaries. The former Building 271, formerly located just north of the existing Building 201 where the Doyle Drive/Highway 101 is now located, included a blacksmith shop. The need to expand these facilities initiated the partial filling in of the marsh and slough, first to construct road access to wharves along the bayshore (Bank and Halleck Streets); then to construct additional stable and other facilities associated with the Quartermaster duties of the military post. The materials used to fill in the marsh and slough include both reworked beach sand and refuse from the Presidio. Significant historic archaeological deposits were found within these landfills during the restoration of the Crissy wetlands in 1998-1999 (*Ambro and Clark, 2003*). Fill associated with Quartermaster disposal activities is considered a historic resource. Currently, archeologists are assessing the significance and character of the Quartermaster fill with respect to the Site.

In preparation for the Panama-Pacific Exposition, the Quartermasters facilities and cavalry stables were removed in 1912 and 1913. By the opening of the Panama-Pacific Exposition in 1915, the marsh and sloughs had been completely filled in and the buildings, utilities, and roadways associated with the Exposition had been constructed. Most of the Exposition facilities were dismantled after its closing on December 4, 1915, and the remaining buildings were converted to military use in preparation for World War I.

In 1917, railroad lines were constructed from Fort Mason into the northeastern corner of the Presidio along Mason Street. The Building 38 complex, consisting of Buildings 38, 38A, and a garage, was formerly located east of the Building 207 Exchange Service Station, as shown on Plates 1 and 2. An oil station was present adjacent to the rail line as early as 1921 (*NPSA Maps, 1921, 1928*), and was later designated as of 1934 as a gasoline station (*NPSA Map, 1934*). These rail lines are no longer visible on the surface of the Site.

Between 1933 and 1937, the Golden Gate Bridge and the elevated highway that forms the southern Doyle Drive approach was constructed, with the elevated approach portions passing east to west through the Site, as shown on Plates 1 and 2. During World War II from 1941 to 1945, the level of military activities reached their peak as the Presidio became the nerve center for Army operations in defense of the western United States. Although the Presidio continued to serve as a military installation from the close of World War II to 1999, the period of historical significance is considered to have ended in 1945.

2.2.3 Post-Historic Army Period (1945 – 1994)

The Army primarily used the Building 207/231 area for servicing and fueling vehicles. The following summarizes the history of the area. Details of individual sources within the area are provided in Section 3.0.

The Building 207 Exchange Service Station, located north of and adjacent to the northern Doyle Drive/Highway 101 overpass, was constructed in 1969 (*NPS, 1992*) and contained at least three underground storage tanks (USTs) that were removed in 1996, as shown on Plate 2 (*IT, 1997a*). The Building 231 service station is located in the central portion of the Site along the east side of Halleck Street and is bounded by Gorgas Avenue to the north, Building 230 to the east, and Building 228 to the south. The first Building 231 service station and associated two USTs were present between 1941 and 1950 at the location shown on Plate 2 (*NPS, 1990*). The more recent and larger service station was constructed sometime between December 15, 1950, and April 23, 1958, and is also depicted on Plate 2 (*PAS, 1958*).

Other Army uses of the 207/231 area include: a bakery (1909) (*NPS, 1990, 1992*) and exchange laundry (between 1950 and 1973) (*D&M, 1997*) at Building 228; and a car wash (1969) at former Building 208.

The Army has conducted UST removals, environmental investigations, and other remedial activities, as detailed in Section 3.3. The Army removed all USTs, associated piping, and hydraulic sumps; over

excavated several areas; and performed some soil and groundwater treatment in the Building 231 area. Some of the Army environmental investigation and remediation activities continued until 1999. As discussed in Section 3.4, some areas still have petroleum hydrocarbons and petroleum-related products in soil and groundwater at concentrations that may require additional remediation.

2.2.4 Post-Army Period (1994 to Present)

On October 1, 1994, the Presidio of San Francisco (Presidio) was transferred from the Army to the NPS and became part of the Golden Gate National Recreation Area (GGNRA). In 1998, the Presidio Trust (Trust), a single-purpose federal agency, was granted jurisdiction over 1,168 acres of the Presidio, including the Site. The Army occupied the Site until 1994.

The Trust, collaborating with NPS and community stakeholders, has been completing environmental investigations and corrective actions to cleanup and close contaminated areas within the Building 207/231 area since 1999. Details regarding these investigations are presented in Section 3.3.

2.3 Current and Planned Site Land Uses

Several restoration projects are in the planning stages for the Building 207/231 area. This section describes both current and planned land uses for the Site, as they are understood at this time, and how the planned land uses will affect the development of corrective action alternatives for the Site.

2.3.1 Current Land Uses

The Site currently consists of buildings, roadways, the Doyle Drive/Highway 101 overpasses, paved areas, and some landscaping. Currently, there are five buildings on Site: Buildings 201, 227, 228, 229, 230, and 231. The status of each building is as follows:

- Building 201 is currently occupied by the Presidio Trust and private tenants.

- Building 227 is currently occupied by the Presidio Fire Department. The Trust is planning to lease this historic building; however, the Real Estate Department indicated it will not be leased until 2006.

- Building 228 is currently occupied by Trust personnel. The Trust is planning to lease this historic building; however, the Real Estate Department indicated it will not be leased until 2006.

- Building 229 is currently occupied by Trust personnel. The Trust is planning to lease this historic building; however the Real Estate Department indicated it will not be leased until 2006.

- Building 230, the Presidio Archaeology Lab, is a joint facility of the Presidio Trust and NPS.

- Building 231 is currently occupied by the Presidio Trust High Voltage maintenance group. This group plans to vacate the building in~~ late 2005/early~~ 2006.

As previously noted, the Doyle Drive/Highway 101 overpasses are nearing the end of their useful lifespan. The alternatives for replacing the overpasses are discussed in Section 2.3.2.2.

2.3.2 Planned Land Uses

The following sections summarize the planned land uses, as they are understood at this time. As noted below, the planned land uses are in development and are not expected to be complete prior to the submittal of this CAP. Therefore, the corrective action alternatives developed in this CAP consider all of the alternatives described below, as they are currently understood.

2.3.2.1 Marsh and Freshwater Restoration Projects

As discussed previously, the prehistoric landscape of the Building 207/231 area included a marsh, slough, beach, and dune system. Plate 3a shows the topographic contours as they are believed to have existed in 1871, and Plate 3b shows the historic shorelines and fill locations. In addition, a freshwater stream

referred to as the THRC is thought to have entered the marsh area from the south and entered the marsh approximately between Buildings 230 and 231. During Army occupation prior to 1940, the THRC was channeled underground in a 72-inch diameter reinforced concrete pipe (RCP) that extends through the Fill Site 6A area, located south of the Building 207/231 area, and approaches the Site adjacent to and roughly paralleling Halleck Street. At the downstream end of the project reach, the 72-inch storm drain pipe continues northward under a concrete walkway/stairs, ultimately discharging to the Crissy Field Marsh at the concrete opening just north of Mason Street, as shown on Plate 3a.

In 2000, the NPS, in partnership with the Golden Gate National Parks Conservancy (GGNPC), completed construction of the tidal wetland in Crissy Marsh north of the Building 207/231 area. The wetlands area extends from the San Francisco Bay south to the north side of Mason Street. The NPS, GGNPC, and the Trust are coordinating on a future expansion of Crissy Marsh between Mason Street and south of Building 231, to provide a native habitat corridor from the existing Crissy Marsh to the restored stream south of the Fill Site 6A remediation site. Depending on the characteristics of the site, native habitat enhancement in this area may be a combination of marsh expansion and/or riparian habitat. One of the alternatives under consideration consists of extending the Crissy Marsh to just south of Building 231, possibly to the historic wall located between Buildings 231 and 228 (Plate 3a). The historic wall is located at the approximate location of the original marsh shoreline prior to man-made modifications that began in the late 1800s. The extension of the marsh to the south would result in additional areas being subject to saltwater protection action levels.

The Trust, in partnership with the NPS, is in the process of restoring the freshwater THRC south of the Site at Fill Site 6A. The THRC may be restored as a freshwater stream that will traverse the ecological protection zone and ultimately discharge into the tidal wetlands of Crissy Marsh that may be extended south of Doyle Drive. In the summer of 2005, fill has been removed from the Fill Site 6A Site located south of the Building 207/231 Area; the RCP storm drain is being removed as part of the remediation work; and a future riparian corridor will be restored along this reach. After the fill soil and storm drain

have been removed, the Trust will grade the area to create a new open channel and re-vegetate the area with native and ornamental plants. The new channel will include in-stream features (e.g., rapid-pools), refined grading of off-stream wetlands and transitional upland slopes, and biotechnical stabilization measures. The restoration plan also includes a plan to create a transition from native plant zones within and adjacent to the new stream channel to the landscaped area in the upland areas. The width of the corridor would be at least 200 feet, and may be as wide as 500 to 600 feet (Plate 3a).

In the Building 207/231 Area, one possible location of the THRC may be in between Building 229 to the west and Buildings 1029 and 230 to the east. The discharge point of the corridor would be at sea level and into Crissy Marsh. As previously noted, the final location of the shoreline for Crissy Marsh will not be decided until after the submittal of this CAP. The THRC may discharge as far south as somewhere between Buildings 229 and 230 near the historic wall to as far north as the present discharge point just north of Mason Street. Depending on the to-be-determined location of the shoreline of the restored marsh, the selected corrective action alternative will need to consider the variable plans to restore the THRC. For example, if excavation of the area just north of Building 231 is the selected soil remediation alternative, then it may be advantageous to not fill in the resulting excavation if the marsh shoreline and the THRC discharge point are between Buildings 229 and 230. In any case, because of the variable alternatives for the Crissy Marsh and the THRC, the freshwater and saltwater ecological protection cleanup levels were applied throughout the Building 207/231 Area in this CAP.

2.3.2.2 Replacement of Doyle Drive/Highway 101

The Doyle Drive/Highway 101 overpasses are over 60 years old and are approaching the end of their useful lifespan due to structural degradation (*J&S, 2001*). As shown on Plates 1 and 2, the overpasses currently bisect the Site running parallel to Mason Street east to west. The San Francisco County Transportation Authority (SFCTA) is proposing to replace a 1-1/2-mile portion of Doyle Drive, from Marina Boulevard and Lombard Street to the southern approach to the Golden Gate Bridge. Corrective

action alternatives in this CAP must consider the potential alternatives being considered by the SFCTA for the planned replacement of the Doyle Drive/Highway 101 within the Site boundaries.

The SFCTA is currently developing alternatives to replace Doyle Drive/Highway 101 to improve the seismic, structural, and traffic safety of the roadway within the setting and context of the Presidio and its designation as a national park. The development of the Doyle Drive/Highway 101 replacement alternatives will also consider the expansion of the Crissy Marsh and the restoration of the THRC, as discussed above.

Several potential conceptual options for the replacement structure have been developed, including combinations of replacement, tunnels, and bridges (*Parsons Brinkerhoff, 2004a,b*). Currently, the following three alternatives are being considered: No-Build, Replace and Widen, and Presidio Parkway. The No-Build alternative serves as a baseline and is not likely to be considered. The Replace and Widen alternative would replace and widen the footings and viaducts in generally the same location. The Presidio Parkway alternative involves reconstruction of one viaduct and the construction of four tunnels and two low causeway structures. In the Building 207/231 area, the Presidio Parkway alternative would realign the roadway further south to between its current location and Building 231, as shown on Plate 4. The Presidio Parkway alternative would require the removal of Buildings 201 and 230. Both replacement alternatives would require excavation for the installation of roadway foundations and would likely encounter soil and groundwater with chemicals at concentrations above action levels, unless such remediation is performed prior to the replacement of Doyle Drive/Highway 101.

The selection of the final Doyle Drive/Highway 101 replacement alternative is currently scheduled for December 2006, assuming there are no delays. The construction of the replacement structure is anticipated to begin no sooner that 2009 to 2010. Consequently, the corrective action alternatives in this CAP considered all three Doyle Drive/Highway 101 replacement alternatives.

2.4 Remedial Design Considerations

As discussed above, the protection of cultural and historic resources, natural resources opportunities, and potential or planned land uses will need to be considered in the development of the corrective action alternatives in this CAP. These considerations are summarized as follows:

Cultural and Historic Resources

The Site is situated in the Presidio of San Francisco National Historic Landmark District, an historic site composed of historic landscapes, buildings, archaeological sites, and objects. As discussed above, prehistoric and historic sensitivity zones and cultural/archaeological resources have been identified within the area of the Site. Significant historic and prehistoric archaeological properties have been identified adjacent to the Site (Quartermaster Landfills, CA-SFR-129). The former shoreline of the marsh and slough cuts across the Site. In addition, the location and configuration of the marsh and slough varied with time (Plate 3b), and the confluence area between marsh and freshwater drainages would be coincident with areas where prehistoric occupation would occur. Consequently, prehistoric cultural resources might be present anywhere within the Building 207/231 Area, which resides in the delta of the Tennessee Hollow drainage.

The activities associated with the filling of the marsh and sloughs, the construction of the historic structures, and the activities associated with the use of the structures result in a moderate to high probability that historic period cultural resources might be encountered during intrusive remedial activities anywhere within the Building 207/231 area. Therefore, the corrective action alternatives developed for this CAP include identification and protective measures to be implemented in the event that cultural resources are encountered. As discussed above, specific finds have occurred within the Site.

These resources are protected under the NHPA and Programmatic Agreement between the Trust, California Office of Historic Preservation, NPS, and the Advisory Council on Historic Preservation.

Therefore, corrective action alternatives developed under this CAP considered these resources and the effect the requirements of the NHPA may have on the evaluation and implementation of corrective action alternatives. Accordingly, the following will be considered in the development, selection, remedial design, and implementation of corrective action alternatives:

- Pre-Construction Archaeological Investigation of the Building 207/231 Area: Prior to implementation of the selected corrective action alternatives, an investigation will be performed to assess potential cultural and/or historic resources in this area. The objectives of the investigation include (1) formulating an approach to assess resources that may be present by reviewing pre-existing data (e.g., core samples, boring logs, cross-section profiles); (2) establishing a stratigraphy (i.e., a relationship between fill and native materials) in the areas of proposed impact (e.g., excavation areas); (3) preparing a Work Plan for performing an archaeological field investigation that includes protocols and procedures to be followed in the event archaeological resources are encountered and to process archaeological findings that may be present within contaminated materials; and (4) conducting a field investigation with the intent of identifying historic, prehistoric, and historic structural features in the proposed impact areas by collecting information from trenches located in probable areas of sensitivity.

- Cultural and Historic Resources: Potential impacts to cultural and historic resources that are known to be or may be present within these remedial units (RUs) during implementation of corrective action alternatives would be minimized by (1) conducting a pre-construction archaeological investigation; (2) requiring archaeological monitoring during intrusive activities to prevent adverse impacts; and (3) developing and recommending corrective action alternatives for RUs with identified historic resources that would not adversely affect their integrity (e.g., capping instead of excavation).

Natural Resources

The corrective action alternatives for the CAP considered issues associated with the potential extension of Crissy Marsh into the Site and the ecological protection needs of the restored saltwater habitat. Selection of the preferred marsh expansion alternative is unlikely to be complete before the submittal of this CAP. To account for the uncertainty regarding the implementation of the marsh expansion (that may extend as far south as the historic wall south of Building 231), this CAP assumed saltwater ecological protection cleanup levels would be applicable throughout the Building 207/231 CAP Area.

The THRC may be restored and its courseway will likely coincide with soil and possibly shallow groundwater that currently have chemicals at concentrations above action levels. The location of the shoreline for the Crissy Marsh has not yet been decided and thus the discharge point for the THRC is also undecided. The final extent and configuration of the THRC are currently being developed and are unlikely to be complete before the submittal of this CAP. To account for the unknown final extent and configuration, this CAP assumed that freshwater ecological protection action levels may need to be applied throughout the Building 207/231 Area.

Doyle Drive/Highway 101 Replacement

The selection of the final Doyle Drive/Highway 101 replacement alternative is currently scheduled for December 2006, assuming there are no delays. The construction of the replacement structure is anticipated to begin no sooner than~~t~~ 2009 to 2010. Until a conceptual design is selected, the location and configuration of the structure will be unknown. Therefore, this CAP considers both replacement alternatives.

Replacement of Gorgas Avenue Roadway Section

Corrective actions to remediate contamination beneath a section of Gorgas Avenue and then replace the roadway were included in the alternatives. However, replacement of this section of the Gorgas Avenue

roadway would only be implemented if it were determined to be consistent with future restoration and development plans for this area.

2.5 Regulatory Framework

Regional Water Quality Control Board (RWQCB) Order No. R2-2003-0080 (*Order; RWQCB, 2003*) was issued to the Presidio Trust in August of 2003. As detailed in the Order, the Site is a known petroleum site requiring preparation and implementation of a CAP. The Order presents Site Cleanup Requirements (SCRs) for the protection of human health, ecological receptors, and water quality, which have been used to develop the cleanup levels in this CAP.

This CAP has been prepared in accordance with Task 6 of the RWQCB Order. The CAP also fulfills the California requirements of Title 23, California Code of Regulations (CCR), Division 3, Chapter 16, Article 11 and California Health and Safety Code, Chapter 6.8. Cleanup Levels for the Site are specified in this CAP. Petroleum contaminant cleanup levels are based on the SCRs listed in the RWQCB Order, the planned land uses and site lithology, and the Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water (*Erler & Kalinowski, Inc. [EKI], 2002; Table 7-6 Revised May, 2006; Cleanup Levels Document*). The site-specific Cleanup Levels are developed in Section 4.2. Applicable state and federal laws are identified and presented in Section 6.3.

The Order defines a freshwater ecological protection zone that includes most of the southern portion of the Site and a saltwater protection zone that includes the northern portion of the Site north of the Doyle Drive/Highway 101 overpasses. Plate 2 illustrates the freshwater and saltwater area designations described in the Order. Each ecological protection zone has associated action levels that must be used in developing site-specific cleanup levels. As discussed above in Section 2.3.2.1, plans are being developed for the potential expansion of the Crissy Marsh and the restoration of the THRC.

The Crissy Marsh may be extended as far south as the historic wall to restore the marsh to near its historic shoreline, shown on Plate 3b~~Figure 3~~. This extension of the marsh would create additional saltwater habitat and would correspondingly require the application of saltwater ecological protection action levels south to the restored marsh shoreline. Under this alternative, the THRC would discharge into the marsh at a location approximately between the eastern end of the historic wall and Building 230.

Alternately, the THRC might be extended through the entire Site and discharge into Crissy Marsh at its current discharge location just north of Mason Street. In this land use alternative, the freshwater ecological protection action levels would be applied to include the northernmost portion of the restored THRC.

As previously noted, the planned land use alternatives discussed above are currently being developed and the final alternatives are unlikely to be selected before the submittal of this CAP. To account for the multiple land use alternatives, the corrective action alternatives developed in this CAP used a conservative approach and applied the most conservative of both the saltwater and freshwater ecological protection action levels throughout the entire Site.

2.6 Public Participation

This CAP will be subject to public review and comment including the following:

- Consultation and coordination of corrective action alternatives and selection decisions with the Presidio Restoration Advisory Board (RAB), National Park Service (NPS), and regulatory agencies.
- On March 31, 2005 and May 18, 2005, the Trust conducted coordination meetings with NPS, the RAB, and regulatory agencies soliciting early input on the scope of contamination and potential corrective actions for the Building 207/231 CAP Area.

- Preparation of response to comments received on the CAP. The Trust's responses to RWQCB comments on the Draft~~for this~~ CAP are presented in Appendix C, which indicates these ~~will be completed following receipt of stakeholder~~ comments have been~~and will be~~ incorporated into the~~e~~ CAP.

3.0 SITE BACKGROUND

This section summarizes the geology and hydrogeology, Site history, previous corrective actions and investigations, and describes the source, nature, and extent of known chemicals still present in soil and groundwater at the Site. Plate 5 presents the features referenced in this section including current and former buildings, former fuel islands, former USTs, hydraulic lifts, and sump with unique identification numbers, the former FDS pipeline, previously excavated areas, and the locations of geologic cross sections.

3.1 Site Geology and Hydrogeology

This section summarizes the soil types, stratigraphy, and groundwater conditions encountered during previous investigations and Presidio-wide monitoring programs. The information summarized below was developed from the 1999 Draft CAP *(MW, 1999b)*, which used detailed site hydrogeologic information presented in the Basewide Hydrogeologic Conceptual Model (*MW, 1996a)* and the Final Site Investigation Report (*IT, 1997b*), the Final RI (*D&M, 1997*), data from the 2004 quarterly monitoring events (*T&R, 2005*), ~~and~~ the Data Gaps Investigation (*MACTEC, 2004a, c*), and the results of the *Subsurface Geoarchaeological Survey of the Building 207/231 Area, Presidio of San Francisco, City and County of San Francisco, California (ASC & MACTEC, 2006*).

The Building 207/231 Area is located at the boundary of the Northwestern and Crissy Field groundwater areas of the Marina Groundwater Basin. The main water-bearing zones in the Building 207/231 Area are the shallow, upper intermediate, and lower intermediate zones. These three relatively permeable, sandy, water-bearing zones are separated from one another by two horizons of less permeable, clayey, fine-grained estuarine deposits (Bay Mud) observed across the Crissy Field Groundwater Area. The fine-grained estuarine deposits appear to pinch out south of Building 229, where Quaternary sedimentary deposits (including Pleistocene Colma Formation [older marine sands]) and Quaternary stream deposits

are encountered at elevations above high sea level stands in San Francisco Bay. The Site-specific geology and hydrogeology are summarized below.

3.1.1 Geology

Seven distinct soil units were encountered during previous subsurface investigations at the Building 207/231 Area. These units from the surface down are:

- Fill;
- Shallow Sand;
- Shallow/Intermediate Aquitard;
- Upper Intermediate Sand;
- Intermediate Aquitard;
- Lower Intermediate Sand; and
- Intermediate/Deep Aquitard.

With the exceptions of the Shallow Sand and the Shallow/Intermediate Aquitard, these units are generally continuous across the Site. To illustrate the subsurface geology, the following three geologic cross-sections were created that incorporate data from this Data Gaps Investigation with lithologic data from previous investigations:

- Section A-A’ is located north to south from Mason Street to Building 228 (Plate 6).
- Section B-B’ is located west to east from Building 201 to the former USTs 231.4 through 321.7 to the railroad spur on the east side of Building 230 (Plate 7).

- Section C-C' is located west to east through the former USTs 207.1 through 207.3 to Building 38 (Plate 8).

The locations of the sections are shown on Plate 5. The six units are described below. Based on review of the results of the subsurface geoarchaeological survey of the site conducted in January 2006, the subsurface geology within the nine trenches excavated at the Site was consistent with data from previous investigations, and consisted of varying strata of fill, sands, silts, and clays, with some discontinuous occurrences of gravel fill containing anthropogenic material *(ASC & MACTEC, 2006)*. The lower strata of the trenches contained evidence of native soil in the form of gray fat clay, dark gray, brown, and black poorly-graded sand, and light yellowish brown poorly-graded sand. The gray fat clay typical of Bay Mud deposits was generally discontinuous at the depths excavated within the trenches. The locations of the nine trenches are shown on Plates 19a and 19b. Cross-sections of the trench logs are provided in Appendix A of the *Subsurface Geoarchaeological Survey of the Building 207/231 Area, Presidio of San Francisco, City and County of San Francisco, California* report *(ASC & MACTEC, 2006).*

Fill – Fill material extends from the ground surface to depths ranging from 1 to 16 feet below ground surface (bgs). The fill consists of a heterogeneous mixture of sand, silt, clay, gravel, and construction debris. In the case of the over-excavation for former USTs 231.4 through 231.7, the fill extends through the Shallow/Intermediate Aquitard into the Intermediate Sand. Soil designated as fill was based on the observed presence of debris. Fill material was highly variable, composed of lean clay, silt, sand, and gravel with debris. The debris included fragments of brick, shell, glass, slag, asphalt, chert and serpentinite gravel, visqueen, and resin-like material.

As discussed in Section 2.2, much of the Building 207/231 Area was originally a marsh and estuary that was filled in. Some of the fill material used to fill in the marsh may have been mud and sand from surrounding areas, such as the previously-existing Strawberry Island. As a consequence, the soil samples from some boring logs used for lithologic evaluation may have interpreted the material to be native when

the material is actually reworked native soil. To further evaluate the location and thickness of fill materials, Plates 9 and 10 present an isopleth map depicting the elevation of the top of the Bay Mud, and an isopach map depicting the thickness of fill, respectively. In addition to using information from the available boring logs, the current and 1871 elevation contours were evaluated to identify areas in three-dimensional space that the 1871 elevation contours indicate received fill materials. Consequently, some materials identified in lithologic logs as native soil was re-interpreted as fill.

Shallow Sand – Where present, the permeable, groundwater-bearing Shallow Sand directly underlies the fill and consists of poorly-graded, fine to medium grained sand, clayey to silty sand, and silty sand. The sand may either be in-place shallow marine sand (beach deposits) or dredged sand that was placed as fill. The clayey sand contained from 20 to 40 percent fat clay, and may represent a transitional unit between the marine sand and underlying Bay Mud. The excavation for USTs 207.1, 207.2, and 207.3 extends completely through the Shallow Sand. The excavation for USTs 231.1 through 231.7 may have also extended through the Shallow Sand. The excavation for USTs 228.1, 228.2, and 228.3 encountered the Shallow Sand. Where present, the Shallow Sand thickness ranges from 1 to 9 feet; the top of the Shallow Sand is encountered between 3 and 13 feet bgs.

Shallow/Intermediate Aquitard – This unit underlies the Fill and Shallow Sand units throughout the Site, but is shown as pinching out just south of the Site at Building 229. This unit consists of less permeable, fine-grained estuarine deposits of shallow Bay Mud. The Bay Mud consists of fat clay and fat clay with sand, containing trace to common fibrous organic material silt and clay. As noted above, the excavations for former USTs 231.4 through 231.7 are believed to have extended completely through the Shallow/Intermediate Aquitard, thus connecting the saturated portions of the surface Fill unit with the underlying Intermediate Sand. The Shallow/Intermediate Aquitard thickness ranges from 0 where excavated at the former USTs 231.4 through 231.7 to as much as 12 feet in several areas within the Site; the top of the Shallow/Intermediate Aquitard is encountered between 3 and 16 feet bgs. Plate 9 shows the current elevation of the top of the Bay Mud.

Upper Intermediate Sand – This permeable, groundwater-bearing unit underlies the Shallow/Intermediate Aquitard and is present throughout the Site. The Upper Intermediate Sand is composed of poorly graded, fine to medium grained sand and silty sand. The unit thickness ranges from 4 to 12 feet; the top of the Upper Intermediate Sand is encountered between 11 and 22 feet bgs. In the northern portion of the Site in the area between Building 201 and the former USTs 231.4 through 231.7, the Upper Intermediate Sand appears to merge with the Lower Intermediate Sand, based on the lithology of CPT/HP Boring 231HP17.

Intermediate Aquitard – This less permeable unit underlies the Upper Intermediate Sand throughout the Site and consists of Bay Mud, silt and clay. As noted above, this aquitard was shown to pinch out in the northern portion of the Site in the area between Building 201 and the former USTs 231.4 through 231.7. In the northern portion of the Site at Mason Street and further north, the underlying Deep Sand appears to pinch out. The unit thickness ranges from 0 to 8 feet; the top of the Intermediate Aquitard is encountered between 20 and 26 feet bgs.

Lower Intermediate Sand – In previous reports such as the MW Draft CAP, this unit was referred to as the Deep Sand. However, the investigations at the adjacent Building 1065 area reinterpreted the Deep Sand as a lower portion of the Intermediate Sand. The permeable, groundwater-bearing Lower Intermediate Sand is present through out the Site. The MW Draft CAP indicated the Lower Intermediate Sand pinches out north of Mason Street. This unit consists mostly of poorly graded sand with some silty sand. The bottom of the Lower Intermediate Sand unit has not been encountered in many of the borings drilled in the southern and central areas of the Site. The maximum thickness encountered was 16 feet; the top of the Lower Intermediate Sand is encountered between 18 and 29 feet bgs.

Intermediate/Deep Aquitard – This less permeable unit underlies the Lower Intermediate Sand in the northern portion of the Site at Mason Street and consists of Bay Mud, silt and clay. It is unknown whether this unit extends further south because borings in the central and southern portions of the Site

were not deep enough to reach this unit. The unit thickness beneath Mason Street is at least 25 feet. Further north under Crissy Marsh, borings indicate that the Lower Intermediate Sand pinches out and the Intermediate/Deep Aquitard thickness increases to at least 120 feet. At Mason Street, the top of the Intermediate/Deep Aquitard is encountered at 36 feet bgs.

3.1.2 Site Hydrogeology

Three hydrogeologic units have been identified at the Site. These units generally consist of silty sand or fine to medium poorly-graded sand, separated by silt or clay aquitards. Groundwater generally flows north in all three water-bearing zones with some minor variations in flow directions. Groundwater depth, elevation, flow direction, and gradient data discussed below is from ~~the most recently available~~ four quarters of sampling events in 2004 (First Quarter 2004; Second Quarter 2004; Third Quarter 2004; Fourth Quarter 2004), to illustrate current Site conditions (*T&R, 2005*).

Shallow Groundwater Zone – This zone consists of saturated portions of the Fill and Shallow Sand units. Groundwater in this unit occurs under unconfined conditions. During the 2004 quarterly groundwater-level monitoring events, groundwater was encountered at depths ranging from 1.78 to 12.75 feet bgs and at elevations ranging from 5.17 to 12.10 feet PLLW. For the December 2004 monitoring event, groundwater flow was mostly north-northwest with localized flow directions ranging from north-northwest to north-northeast. The hydraulic gradients ranged from approximately 0.011 to 0.033. A slug test performed on Shallow Sand Well 231GW11 indicated a hydraulic conductivity of 1.1 to 1.4 feet per day (*Stollar, 1992*). Vertical gradients between the Shallow Zone and the Upper Intermediate Zone, and between the Shallow Zone and the Lower Intermediate Zone are consistently upward, on the order of 0.1 to 0.2 feet/foot.

Upper Intermediate Groundwater Zone – This zone consists of groundwater in the Upper Intermediate Sand unit. Groundwater in this zone is semiconfined with the Upper Intermediate zone water levels typically one to two feet higher than the Shallow zone water levels (*MW, 1999b*). During the 2004

quarterly groundwater-level monitoring events, groundwater was encountered at depths ranging from 2.03 to 10.50 feet bgs and at elevations ranging from 4.55 to 11.53 feet PLLW. For the December 2004 monitoring event, groundwater flow was generally north to north-northeast. The hydraulic gradient ranged from approximately 0.006 to 0.010. A slug test performed on Upper Intermediate Sand Well 231GW07 indicated a hydraulic conductivity of 0.47 to 0.62 feet per day; a slug test performed on Intermediate Sand Well 231GW12 indicated a hydraulic conductivity of 3.8 feet per day (*Stollar, 1992*). Vertical gradients between the Shallow Zone and the Upper Intermediate Zone, and between the Upper Intermediate Zone and the Lower Intermediate Zone are consistently upward, on the order of 0.1 to 0.2 feet/foot.

Lower Intermediate Groundwater Zone – This zone consists of groundwater in the Lower Intermediate Sand unit, formerly known as the Deep Sand unit. Groundwater in this zone is confined with the water levels typically one to two feet higher than the Upper Intermediate zone water levels (*MW, 1999b*). For the 2004 groundwater-level quarterly monitoring events, groundwater was encountered at depths ranging from 1.18 to 3.04 feet bgs and at elevations ranging from 10.66 to 11.53 feet PLLW. For the December 2004 monitoring event, groundwater flow was to the north-northwest across the Highway 101 area, the only area within the Site with Lower Intermediate Groundwater Zone wells. The hydraulic gradient was approximately 0.0008. Vertical gradients between the Shallow Zone and the Lower Intermediate Zone, and between the Upper Intermediate Zone and the Lower Intermediate Zone are consistently upward, on the order of 0.1 to 0.2 feet/foot.

3.2 Site History

The Building 207/231 Area includes the former or present locations of Buildings 38, 38-A, the Building 38 Garage, 119, 202, 203, 206, 207, 208, 227, 228, 229, 230, 231, 271, and the area just west of former Buildings 119 and 271 (Plate 5). The Site consists of former and existing buildings, paved parking areas, roadways, the Highway 101/Doyle Drive overpasses, and some landscaping.

Site use histories for the former and existing buildings that are part of the Building 207/231 Area were discussed in detail in the Data Gaps Work Plan and are briefly summarized below. Each area includes buildings that have been grouped on the basis of their geographic location at the Site and/or similar use histories. Plate 5 shows the building and UST locations with unique identification numbers. Table 1 summarizes the USTs, hydraulic lifts, and a sump discussed in the sections below.

Former Building 38 Oil Station and Garage Area (Former Buildings 38, 38-A, and Garage) – Prior to modifications that began when the U.S. Army occupied the Presidio, this area was originally in the generally east-west oriented channel and marsh that separated the original Presidio area to the south from Strawberry Island to the north (*J&S, 2001*). As previously discussed, filling of the channel and marsh began in approximately the 1890s and was largely completed in the early twentieth century (*J&S, 2001*). The 1916 site map does not show former Building 38 (*NPSA Map, 1916*). Former Building 38 is identified as an Oil Station on the December 1921 and June 1928 site maps (*NPSA Map, 1921, 1928*); the structure is also shown on the September 23, 1933, site map (*NPS, 1933*). A text description of this building has not been located. The proximity to railroad tracks suggests the building may have supplied oil and perhaps other equipment and supplies for the railroad trains. Alternately, the building may have stored fuel or heating oil for use by the local buildings. In any case, because of the designation as an oil station, heavier end petroleum hydrocarbons were probably stored and used at this location at least from December 1921 through September 23, 1933.

On the December 1934 site map, a gas station is identified on the southeast corner where Gorgas Avenue intersected Mason Street (Gorgas no longer intersects Mason) and is identified as "Gas Station" and Buildings "38, 38-A, and Garage" (*NPSA Map, 1934*). The site map did not identify the location or presence of USTs or above ground fuel or oil storage tanks.

Former Buildings 38, 38-A, Garage and 40 are also visible on the 1935 aerial photograph that shows the Doyle Drive overpasses construction in progress and rapidly approaching the Mason/Gorgas/Halleck

intersection (*PAS, 1935*). On the November 13, 1936, aerial photograph, the southern Doyle Drive overpass has been completed through the area and the northern overpass is under construction (*PAS, 1936*). The locations of Buildings 38 and 38-A are just north of where the northern overpass will pass; the Garage would have been exactly in the footprint of the overpass. All the structures noted in this area had been removed except possibly Building 38-A. A railroad spur arcing across the northernmost portion of this area and extending (in the near future) to the eastern side of Building 230 appears to be under construction. Former Buildings 38, 38-A, and the Garage are shown on Plates 2 and 5 and are assumed to be potential historic sources for petroleum hydrocarbon releases. Information on the location of the fuel storage tanks for former Building 38 has not yet been found.

In the 1938 aerial photograph, both overpasses have been completed and are in use (*PAS, 1938*). Gorgas Avenue has been rerouted parallel to the southern overpass and not under the overpasses. Halleck Street had not yet been reconnected to Mason Street and a remnant of Gorgas Avenue was visible between the overpasses. The railroad line from the now-present Building 230 arcs through the northern part of the area and connects with the tracks along Mason Street as shown on Plate 5 (the rail line is no longer visible at the surface that is paved). Former Building 38-A appears to still be present but it is unclear whether the building was still in use. The associated garage would be under the current location of the northern overpass and had probably been removed by then. From the February 25, 1943, site map (*NPSA Map, 1943a*) to the April 23, 1958, aerial photograph (*PAS, 1958*), no structures are shown or visible in the Building 38 area.

Former Building 207 Exchange Service Station Area (Former Buildings 202, 203, 206, and 207) – Former Buildings 202, 203, 206, and 207 are located in the northern portion of the Site. Building 206 was the former Exchange Service Station canopy, Building 207 was the former Compressor Building, and Buildings 202 and 203 were storage sheds for the Service Station. The Building 207 Exchange Service Station was constructed in 1969 (*PAS, 1969*). Plate 5 shows the locations of the former buildings and the three former USTs (Tanks 207.1, 207.2, and 207.3). Buildings 202, 203, 206, and 207 were demolished

in July 1996 along with the removal the three 10,000 to 10,750-gallon USTs 207.1, 207.2, and 207.3 and associated pump islands and product piping (*IT, 1997a*). As part of the 1996 UST removal, contaminated soil was excavated to 12 feet bgs in the 1996 excavation area shown on Plate 5. The 1996 excavation was backfilled with pea gravel to 4.5 feet bgs, soil treated using low temperature thermal desorption (LTTD) to 18 inches, and imported soil from 18 inches to the ground surface. The 1996 excavation area was subsequently landscaped as part of the Crissy Field Restoration. In 1998, additional contaminated soil was excavated to 5.5 feet bgs from the area north of Former Building 206 and the former USTs (Plate 5; *IT, 1999a*). The 1998 excavation was backfilled with gravel and imported soil.

Former Building 208 – Car Wash – Building 208 is located south of Building 206, in the central portion of the Site. The car wash was built in 1969 and demolished on June 4, 1999 (*Trust, 1999*). Plans for the car wash showed an equipment room, one automatic bay, and two manual car wash bays. In addition, the car wash had a sump, designated Sump 208, in the manual bay adjacent to the equipment room (Plate 5). The sump had a 2-stage sand and oil water separator that collected water from the car wash bays and was fitted with piping that connected to either the sanitary sewer or storm drain system. The sump area was over-excavated and excavation confirmation soil samples collected on June 8, 1999.

Building 228 - Bakery / Exchange Laundry – Building 228 is located in the southern portion of the Site. Building 228 was constructed in March 1909 for use as a bakery. It was later used as the exchange laundry (*NPS, 1990, 1992*). The building was converted to a warehouse sometime in the 1940s. Use as a laundry reportedly began sometime between 1950 and 1973. Water analysis records, dated in the 1970s, for unspecified industrial water treatment were still within the building as of 2004. This suggests that treatment of wastewater, presumably associated with the dry cleaning operations, was occurring in the 1970s. Reportedly, dry cleaning equipment within Building 228 has not been in service since 1984 or 1985, and the equipment is still inside the building. Dry cleaning facility Stoddard solvent tanks and associated fuel oil distribution lines leading to the building have been removed. From 1984 through at least 1990, the building was used for drop-off and pick-up of dry cleaning with the actual cleaning

performed at an off-post facility (*ANL, 1989*). Three 750-gallon USTs (Tanks 228.1, 228.2, 228.3) were located on the north side of Building 228 and contained Stoddard solvent used for dry cleaning. The USTs were removed on June 14, 1993 (*ECC, 1993b*).

<u>Section BR10-1, Presidio Fuel Oil Distribution System (FDS) Pipeline</u> – Section BR10-1 of the Presidio Fuel Oil Distribution System (FDS) Pipeline extended along the west side of Halleck Street, crossed Halleck Street to Building 228, passed along the south side of the building, and entered the building on the east side, as shown on Plate 5. The BR10-1 section consisted of a 6-inch-diameter steel pipe (*IT, 1999b*). Construction of the Presidio FDS Pipeline began in the 1900s (*MW, 1995b*). Records of the installation of the section routed to Building 228 have not been located and its date of installation is unknown. A July 25, 1908, building plan shows a 20 HP boiler at the location where the FDS Pipeline entered Building 228, suggesting the line may have been installed by 1908; however, the building itself was not built until 1909 (*NPSA, 1908*). Use of the FDS pipeline ceased prior to November 1975 (*IT, 1999b*). In August of 1996, the Section BR10-1 pipeline was removed or abandoned. The excavation was backfilled with LTTD-treated soil.

<u>Building 230 – Warehouse / Stores / Currently Presidio Archaeology Group and Railroad Spur</u> – Building 230 is located along Gorgas Avenue in the east portion of the Site, as shown on Plate 5. Former Building 43 (58 by 225 feet), slightly longer than the later Building 230 (75 by 136 feet), was originally constructed at this location in 1917 (*NPS, 1990, 1992*) and remained in this configuration until at least December 1934 (*NPSA Maps, 1909, 1930, 1934*). The 1935 aerial photograph shows the location to be vacant (*PAS, 1935*) and aerial photographs taken after 1936 show Building 230. In 1987, the Post Exchange moved into and upgraded the building to be used as a warehouse (*NPS, 1993*). In 1992, the building was used as a department store (*NPS, 1992*). In 1993, the building was in use as the Post Exchange (Four Seasons and Toyland) and warehouse (*NPS, 1993*). The building is currently used by the Presidio Trust and the NPS archeology group. A railroad spur was present along the eastern side of Building 230 from at least June 1916 (*NPSA Map, 1916*) to as late as October 16, 1961 (*NPSA Map,*

1961) and possibly 1969 (*PAS, 1969*). The rail line is no longer visible at the surface that is paved. The building has a raised loading dock along the eastern length of the building that feasibly was used for loading and unloading from the railroad spur.

Building 231 Area – Post Exchange Gas Service Station – The Building 231 area is located in the central portion of the Site along the east side of Halleck Street and is bounded by Gorgas Avenue to the north, Building 230 to the east, and Building 228 to the south. This area has been occupied by several buildings identified as "Building 231" with different locations and footprints all in the same localized area. The locations of the former USTs are shown on Plate 5. A fire station and service stations were shown at locations northeast of the current Building 231 location as early as July 2, 1941 (*NPS, 1990; ANL, 1989; NPSA Maps, 1943a, b, 1948; PAS, 1946, 1948*). The more recent and larger service station was constructed sometime between December 15, 1950 and April 23, 1958 (*PAS, 1958*). Four USTs (Tanks 231.4 through 231.7) were removed from the Site in 1988 (*NPSA, 1988; Martech, 1988*). The current Building 231 previously contained six hydraulic lifts (Lifts H1 through H6). The above-ground portions of the hydraulic lifts were removed on January 28, 2000, and the subsurface portions of the hydraulic lifts were removed between December 9 and 20, 2002 (*Trust, 2003*). A 1,000-gallon gasoline UST (Tank 231.2) located between Buildings 228 and 231 and a 600-gallon waste oil UST (Tank 231.1) were formerly located beneath the south wall of Building 231, as shown on Plate 5. Both of these USTs were removed in 1996 (*ECC, 1993a; IT, 1997a, 1998*).

Building 271 – Blacksmith Shop and Garage – Former Building 271, located in the northwest portion of the Site on the west side of Halleck Street just north of Building 119 (the future Building 201), is shown on the 1930 and 1934 maps (*NPSA Maps, 1930, 1934*), but not on the 1909 map (*NPSA Map, 1909*). The 1935 aerial photograph shows the building was removed to make way for the Doyle Drive overpass. The building is identified in an undated photograph as a blacksmith shop (*J&S, 2001*) and a garage on the 1930 map (*NPSA Map, 1930*).

3.3 Previous Site Investigations and Corrective Actions

Previous investigations and corrective actions were conducted by the Army to assess the nature and extent of contamination at the Building 207/231 Area, remove USTs, perform corrective action activities, and evaluate corrective action alternatives. In addition to further investigating the Site, the Trust is currently conducting a basewide groundwater monitoring program that includes the sampling of wells at the Site. These investigations and monitoring programs are summarized below. The analytical data generated from these previous and ongoing activities are discussed in Section 3.4, wherein the analytical data are evaluated to assess the current nature and extent of chemicals at the Site.

3.3.1 Records Reviews

The Environmental Research Division of the Argonne National Laboratory performed an Enhanced Preliminary Assessment (PA) of the Presidio Military Reservation to characterize environmentally significant operations, identify areas requiring immediate corrective actions, and evaluate areas that may need further investigations (*ANL, 1989*). The Enhanced PA consisted of a review of site records, aerial photographs, data from regulatory agencies, interviews with Presidio personnel, and observations made during site visits. The Enhanced PA report identified various areas with potential or known environmental issues, including the fuel or solvent USTs at Buildings 207, 228, and 231, and the sump at the Building 208 car wash. The information gathered during the PA was used to develop the scope of work for the Dames & Moore RI, discussed in Section 3.3.3.

As a part of developing the Data Gaps Work Plan (*MACTEC, 2004a*), MACTEC performed a review of records at the Trust's library, the Trust's Archeology Group, the NPS's Archives, and the NPS's library. The results have been folded into this Work Plan. The primary objectives were to develop a detailed history of the Site (Section 3.2), review the results of previous investigations (this section), and acquire

the existing analytical data from previous investigations to reevaluate the nature and extent of chemicals at the Site (Section 3.4).

3.3.2 Removal and Over-Excavation Activities

The following bulleted paragraphs summarize the UST and FDS Pipeline removals and include, where available, information on the contents, leak testing, removal, excavation, and backfill activities conducted. In addition, the possible USTs are listed along with comments on whether any investigation or remedial activities have been conducted in their vicinities (e.g., over-excavations, soil vapor extraction, or groundwater extraction). The summary of known and potential sources on Table 1 includes all of the known removed USTs, along with possible and potential USTs. Plate 5 shows the locations of the USTs, Sump 208, and associated excavations discussed below, organized from south (upgradient) to north (downgradient).

- **FDS Section BR10-1 Investigation and Removal** – In August of 1996, all of Section BR10-1 of the FDS Pipeline was removed except for a 24-foot section near Building 201, a 10-foot section at the southwest corner of Building 228, and the end of the pipeline within Building 228, shown on Plate 5 (*IT, 1999b*). The small sections were abandoned in place due to subsurface utilities. The removal report did not specify how the end of the pipeline that entered Building 228 under the foundation was handled or what was at the end of the pipeline where it passed under the foundation to the building. Pressure testing was reportedly not performed on this section prior to removal or abandonment in place. The removal trenches were typically 18- to 24-inches wide and 3-feet deep. Soil samples were collected at a frequency of one per 100 lineal feet or at turns in the pipeline. The soil samples were analyzed for total petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PAHs) by immunoassay and the analytical results compared to action levels used at the time. With the exception of the remedial excavation at the south side of Building 228, discussed below, the trenches were backfilled with imported topsoil.

The excavation adjacent to the south side of Building 228 was performed from August 19 to 21, 1996. Soil along the southeast side of the Building 228 was visually observed to be contaminated, prompting analytical testing. The analytical testing confirmed contamination. Approximately 40~~1~~ cubic yards (cy) were excavated from the 20 by 7 by 6 foot deep excavation. Some soil with petroleum hydrocarbon concentrations above the action levels used at the time was left in place beneath the foundation so as not to compromise the structural integrity of the building. The excavation was backfilled with LTTD soil to the surface and then paved. Analytical records for the LTTD soil used as backfill for this excavation have not yet been located. Analytical results for the backfill used in other excavations of the FDS Pipeline along Halleck Street have been located, suggesting that records for the backfill used for the Building 228 excavation were either lost or not recorded.

- **USTs 228.1, 228.2, and 228.3** – Documentation regarding tank integrity testing has not been located. The contents of USTs 228.2 and 228.3 were analyzed in product samples collected November 9, 1990 and October 30, 1991, respectively (*D&M, 1997*). The product was concluded to be Stoddard solvent, a common dry cleaning solvent consisting of a mixture of C7 to C12 petroleum hydrocarbons, as discussed in Section 3.4.2. Prior to removal, product samples were collected from USTs, 228.1 and 228.3 on May 25, 1993; UST 228.2 was empty. For the 1993 samples, only the result from the UST 228.1 sample was in the report (*ECC, 1993b*). The product was also concluded to be Stoddard solvent. The 1993 sample was also analyzed for chlorinated volatile organic compounds (VOCs); chlorinated VOCs, including PCE, were not detected above reporting limits.

The 500-gallon USTs 228.1, 228.2 and 228.3 were removed from the north side of Building 228 on June 14, 1993, along with 344 feet of piping connected to Building 228, and approximately

60~~57~~ cy of soil (*ECC, 1993b*). Visual inspection of the tanks did not indicate damage or leakage. Approximately 575 gallons of liquid were removed from USTs 228.1 and 228.3; UST 228.2 was empty at the time of removal. Soil in the excavation was observed to be visually stained. Confirmation soil samples were collected at the base of the excavation as discussed in Section 3.4.2. The excavation was lined with 10-mil plastic sheeting, and then backfilled with compacted borrow material from an unspecified source to the ground surface. The results of compaction tests stated that the borrow material was brown poorly-graded sand with silt and grey-brown poorly-graded gravel with sand. The backfilling occurred prior to the LTTD soil treatment operations, so the backfilled material was not LTTD soil.

- **UST 231.2** – On June 14, 1993, the 1,000-gallon gasoline UST 231.2 and approximately 28 feet of associated piping, located behind Building 231, was removed (*ECC, 1993a*). The removal report did not indicate whether the tank had previously been leak tested. Approximately 500 gallons of product were pumped from the tank and disposed offsite. A sample of the tank contents indicated TPH (unspecified range), benzene, toluene, ethylbenzene, xylenes (BTEX), and chloromethane. The tank was observed to have signs of corrosion, structural damage, and leakage. Stained soil was observed in soil around the tank and was confirmed by the analysis of soil along the north wall of the excavation. Approximately 7,500 cy of soil was also excavated and disposed offsite. Approximately 100 gallons of groundwater were pumped from the excavation and disposed offsite. The excavation was lined with plastic sheeting and backfilled with approximately 6 cy of borrow material and 4 cy of granular material (3/4-inch Class II baserock) to 8 inches bgs, aggregate base to 2 inches bgs, and asphalt to grade.

- **UST 231.1** – This UST passed a tank tightness tests on December 9, 1992 (*MW, 1994*) and June 24, 1994 (*MW, 1995a*). On November 27, 1996, the 600-gallon waste oil UST 231.1, located just inside the back of Building 231, was removed by excavating both inside and outside the back wall and dragging the UST outside (*IT, 1997a, 1998*). The disposal records describe the tank

volume as 807 gallons. The tank and associated piping appeared to be in good condition and contained an unspecified amount of waste oil. The oily liquid inside the tank was not tested. However, stained soils were observed on the soil surrounding the tank. An oily sheen was observed on the groundwater that rapidly filled the excavation pit after the tank removal. Petroleum hydrocarbons (gasoline, diesel, and fuel oil ranges), polycyclic aromatic hydrocarbons (PAHs), chlorobenzene, and polychlorinated biphenyl (PCB) Arochlor 1016 were detected in the groundwater sample collected from the ponded water. Approximately 2,990 gallons of water were pumped from the pit and disposed of offsite; the removal report did not say whether water continued to fill the pit. Approximately 30 cy of soil from the tank removal was disposed of offsite. Excavation to remove contaminated soil could not be performed without compromising the integrity of Building 231. The excavation was backfilled to 6 inches bgs with drain rock and finished with concrete.

- **Hydraulic Oil Lifts H1 through H6** – On January 28, 2000, a Trust contractor (L&W Environmental) removed the above-ground rack portions of the lifts and disposed of 300 gallons of hydraulic oil offsite (*Trust, 2003*). The contractor noted the lifts were powered by an air compressor. A report was not prepared.

  The subsurface portions of the hydraulic lifts were removed by a Trust contractor between December 9 and 20, 2002. The contractor noted concrete or hard rock to be within approximately 3 feet bgs with fill between the concrete floor slab and the bedrock. Visual staining and odors were noted in the subsurface area of Lift No. 5; no visual staining or odors were noted in the subsurface areas of the other lifts. Groundwater filled the holes for lifts H1 through H5 to 3 feet bgs; the hole for Lift H6 filled to 9 inches bgs.

  All of the soil and groundwater samples were collected and analyzed for TPH as gasoline, diesel, and fuel oil, BTEX, and methyl tertiary butyl ether (MTBE). Selected samples were analyzed for VOCs, PAHs, PCBs, and the metals arsenic, copper, lead, nickel, and zinc. In the soil samples

from Lifts H1 through H5, TPH in the fuel oil range [presumably hydraulic oil] was the primary petroleum hydrocarbon detected above reporting limits; lesser concentrations of weathered gasoline and diesel were also detected. In the groundwater samples from lifts H1 through H5, weathered TPH as gasoline was the primary petroleum hydrocarbon detected above reporting limits; lesser concentrations of fuel oil [hydraulic oil] and diesel were also detected. In the soil sample from Lift H6, TPH as fuel oil [hydraulic oil] and weathered gasoline were the primary petroleum hydrocarbons detected above reporting limits with a lesser concentration of weathered diesel. In addition, various metals and PCB 1016 were detected above reporting limits. In the grab groundwater sample from Lift H6, TPH as gasoline was the primary petroleum hydrocarbons detected above reporting limits with a lesser concentration of fuel oil [hydraulic oil]. In addition, various metals and PCB 1016 were detected above reporting limits. The nature and extent of chemicals detected in the lift samples are discussed in Section 3.4.5.

- **USTs 231.4 through 231.7** – The 10,000-gallon USTs 231.4, 231.5, 231.6 and 231.7, located west and adjacent to fuel islands at Building 231, were removed from the Site in November 1988 (*ELM and Martech, 1991*) after failing system integrity tests (*D&M, 1997*). The tanks reportedly contained leaded and unleaded gasoline. During the removal, the four USTs, the associated fuel islands and piping, approximately 700 cy of contaminated soil, and approximately 5,300 gallons of groundwater from the excavation were removed and disposed of offsite (*ELM and Martech, 1991*). The ELM and Martech report did not specify whether the tanks had any contents, removal manifests have not yet been located, and the exact dimensions of the excavation were only approximately documented. Approximately 4,000 gallons of floating hydrocarbon product was also removed from the water table in the excavation (*RWQCB, 1991a*); the RWQCB letter did not specify whether the 4,000 gallons were in addition to or a subset of the 5,300 gallons cited in the ELM and Martech report. The excavation was backfilled with an unspecified material (*ELM and*

Martech, 1991). The backfilling occurred prior to the LTTD soil treatment operations, so the backfilled material was not LTTD soil.

- **Former Building 271 Garage –** The garage was removed in 1934 or 1935. No records regarding specific chemical usage or the presence of storage tanks are known to exist.

- **Sump 208** – The car wash structures were removed on June 4, 1999, exposing the sediment sump (*Trust, 1999*). The sump was inspected and appeared to be in good condition with no observed cracks or damage. Two chambers and the two inlet pipes were observed as detailed in NPSA Map, 1968 and shown in the sump detail on Plate 5. Following the inspection, the sump was demolished and removed.

  The area of the sump was over-excavated and three soil samples were collected on June 8, 1999 (*Trust, 1999*). A black, odorous, oily sand was observed at 4.5 feet bgs, beneath where the bottom of the sump had been, along with some broken sections of iron and plastic pipe, trash, and bricks. The lateral extent was approximately 2 feet in diameter and one foot thick. Samples for chemical analysis were collected from soil adjacent to two inlet pipes and from the black, oily sand. The oily soil was found to contain petroleum hydrocarbons in the diesel range and may have contained more petroleum hydrocarbons in the oil range (see Section 3.4.9 for analytical data discussion). The former sump area, including the black, oily sand, was over-excavated, resulting in a 7 by 13 by 5-foot deep excavation. The excavation was backfilled by grading the surrounding soil into the excavation.

- **USTs 207.1, 207.2, 207.3** – All three USTs passed leak tests performed on May 14, 1987 (*MW, 1994*) and on August 10, 1994 (*MW, 1995a*). In July of 1996, Buildings 202, 203, 206, and 207 were removed; USTs 207.1, 207.2, 207.3 were removed on July 25, 1996, along with the fuel islands, associated piping, and approximately 930~~25~~ cubic yards (cy) of contaminated soil (*IT, 1997a*). Several holes were observed in the top surfaces of the USTs. The lateral extent of the

1996 excavation is shown on Plate 5. The maximum depth of the excavation was 12 feet bgs. Soil beneath the USTs was not excavated deeper, presumably because groundwater was encountered at approximately 8-1/2 feet bgs. Photographs of the excavation show one subsurface utility line crossing the excavation and that soil beneath that line had been removed.

The UST removal report stated that soil with concentrations of gasoline, benzene, ethylbenzene, and xylenes above the action levels used at the time remained in place. The soil action levels used for the 1996 excavation were as follows in milligrams per kilogram (mg/kg) as cited in the tank removal report (*IT, 1997a*) and referenced to the 1996 SCRs (*RWQCB, 1996*):

Depth in feet	0 to 2	2 to 3	3 to 8.5
Gasoline	610	610	1,690
Benzene	1.5	5	1
Ethylbenzene	60	60	19
Toluene	270	270	14
Total xylenes	55	55	4,340

Gasoline range petroleum hydrocarbons, BTEX, and MTBE were detected in the groundwater samples collected from the excavation. The contaminated soil was transported to the Presidio LTTD unit for treatment. The excavation was backfilled with pea gravel to approximately 4-1/2 feet bgs, a geofabric on top of the gravel, LTTD-treated soil to 18 inches bgs, and imported topsoil to the ground surface. The area was then hydroseeded. The LTTD soil is discussed in Section 3.3.4.

The analytical results from the 1996 removal action indicated that unexcavated soil along the north and east side of the excavation had petroleum hydrocarbon concentrations above action levels used at the time (*IT, 1997a*). From late May to early July 1998, IT performed an additional excavation adjacent and north of the 1996 excavation extending into Mason Street (*IT, 1999a*). The action levels used for the 1998 excavation were as listed below in mg/kg as cited in the tank removal report (*IT, 1999a*) and also referenced to the 1996 SCRs (*RWQCB, 1996*). The

differences in most of the action levels occurred due to the development of salt-water eco-protection values developed by the Army subsequent to the SCRs (*USACE, 1997*).

Depth in feet	3 to 8.5
Gasoline	11.6
Benzene	1
Ethylbenzene	5
Toluene	14
Total xylenes	22

The 1998 excavation removed soil to approximately 5.5 feet bgs, just above the depth to groundwater. The two excavations overlapped except for one small area, as shown on Plate 8. A natural gas main crossed the excavation; the gas line was supported with wood blocks and the soil beneath the line was excavated with shovels. A concrete-encased fiber optic conduit also crossed the excavation at 4.5 to 5 feet bgs. The unreinforced concrete conduit could not be safely supported and soil beneath the fiber optic line was not excavated. A total of 2,071 tons of soil were disposed at an offsite disposal facility. Once the excavation was extended to just below the water table, a slight hydrocarbon sheen developed on the surface. The affected water was confined with a floating boom and approximately 200 gallons of petroleum hydrocarbons and water were skimmed off, stored, and later discharged to the sanitary sewer with permit approval. The excavation was backfilled with gravel at the excavation base and compacted under the natural gas line. Imported soil was used to backfill the rest of the excavation. The Site was then restored to pre-excavation conditions including grade, road base, pavement, curbing, and landscaping.

3.3.3 Site and Remedial Investigations

Hallenbeck Investigation – In 1987, five soil borings were drilled around the then-existing USTs 231.4 through 231.7 to test the soil for petroleum hydrocarbons (*Hallenbeck, 1987*). TPH as gasoline, and BTX were detected in soil, and Hellenbeck concluded the tanks and/or product lines were leaking.

Martech Investigation – In December 1988, eight soil borings were drilled to aid in defining the extent of contamination from USTs 231.4 through 231.7 ; three of these borings were completed as monitoring wells (231GW01, 231GW02 and 231GW03) (*Martech, 1988*). Based on laboratory analysis of soil samples from the borings, it was estimated that an additional 1,000 cy of soil containing petroleum hydrocarbons remained in place (*E.C. Jordan, 1990*).

Dames and Moore Remedial Investigation Phases – A three-phase remedial investigation (RI) for the Presidio began in December 1990 and the Final RI Report was released in January 1997. The original contract was between the Army and R. L. Stollar and Associates (*Stollar, 1992*). The contract was transferred to Watkins-Johnson Environmental (WJE) when Stollar was acquired by WJE. The contract was then transferred to Dames & Moore in 1995 upon acquisition of WJE. The contract covered many areas of the Presidio; the discussion below focuses on Site activities.

During the initial RI field program in 1990, ten soil borings, and hand auger borings were drilled near Building 231 to characterize the nature and extent of target analytes in subsurface soils from known and potential sources. Four of these borings were completed as monitoring wells (231GW04, 231GW05, 231GW06, and 231GW07). Groundwater samples were collected from these four wells and the three existing wells, and analyzed to assess groundwater quality in the area. The initial RI analytical results indicated that the hydrogeology and extent of groundwater contamination had not been fully characterized.

The Building 231 area was further investigated as part of a project identified as an interim remedial action (IRA). The purpose of the IRA was to collect data to supplement the RI. IRA field activities included the drilling of seven soil borings and installation of five monitoring wells (231GW08, 231GW09, 231GW10, 231GW11, and 231GW12) to further characterize hydrogeologic conditions, chemical migration, and potential sources at Building 231. The results of the IRA groundwater sampling are presented in the IRA

report (*Stollar, 1992*) and summarized in RI Table 8.2-9 (*D&M, 1997*). Hydrogeologic data collection included rising head slug tests to estimate hydraulic conductivity.

During the follow-on phase of the RI conducted in 1994 and 1995, additional seven soil borings and seven monitoring wells (231GWI3, 231GW15, 231GWI6, 231GWI7, 231GW18, 231GW19, and 231GW20) were installed and sampled in the Building 231 area to more fully characterize the extent of contamination. In addition, Monitoring Well 231GW05 was destroyed and abandoned before the April 1995 quarter began. Monitoring Well 231GW21 was installed as a replacement well and is screened across the uppermost water-bearing zone. Three well clusters were installed to evaluate vertical gradients and the vertical extent of contamination. The three well clusters are 231GW17, 231GW18, 231GW19 (Well Cluster 1), 231GW06, 231GW20, 231GW21 (Well Cluster 2), and 231GW13, 231GW15, 231GW16 (Well Cluster 3). An assessment of site hydrogeology and the nature and extent of constituents of concern at the Building 231 area was included in the Final RI Report (*D&M, 1997*).

The RI did not consider the Building 231 Area in the Baseline Risk Assessment because the primary constituents of concern were petroleum hydrocarbons and the suspected sources were former USTs. The RI recommended removing the Site from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process and completing remedial screenings under the Petroleum Sites Cleanup Program.

IT Site Investigation – In March 1997, a site investigation (SI) of soil and groundwater contamination was conducted near Buildings 207 and 231 to define the extent of petroleum related compounds resulting from releases discovered during the UST removal operations. In addition, the SI provided additional subsurface information to supplement and refine the hydrogeologic model in support of this CAP. SI field activities included drilling 57 soil borings and direct-pushing 54-cone penetrometer test (CPT)/HydroPunch samples. Vadose and saturated zone soil samples were collected for petroleum hydrocarbon and VOC analyses. HydroPunch groundwater sample analyses included petroleum

hydrocarbon, VOCs, and biological parameters relevant to natural attenuation processes. Based on the results of the HydroPunch investigation and delineation of the hydrocarbon plume, nine additional monitoring wells (231GW22 through 231GW30) were installed at the Site and added to the quarterly monitoring program. The results of the investigation along with boring logs and well construction details for CPT/HydroPunch borings, soil boring, and monitoring wells, are presented in the Final Building 207/231 Site Investigation Report (*IT, 1997c*).

Montgomery Watson Investigations – In 1994, a site investigation was conducted at Building 228 near the location of the removed 500-gallon Stoddard solvent USTs (USTs 228.1, 228.2 and 228.3). The site investigation activities included drilling soil borings, and collecting subsurface soil and groundwater grab (HydroPunch) samples. Details of the site investigation, including results of soil and groundwater sample analyses, are presented in the Final Additional Underground Storage Tank Investigation (AUSTI) Report (*MW, 1996b*). Some low levels of chlorinated solvents (e.g., PCE) were detected in soil samples adjacent to UST 228.2, suggesting that PCE may have also been used as a dry cleaning solvent, as discussed in Section 3.3.

In 1998, a study was conducted to assess the effectiveness of Oxygen Release Compound® (ORC®) filter socks placed in monitoring wells to accelerate the rate of petroleum hydrocarbon degradation. ORC® is a proprietary formulation of magnesium peroxide that slowly releases molecular oxygen when hydrated, promoting microbial growth, and improving the ability of aerobic microbes to degrade fuel contaminants. ORC® filter socks were suspended in the saturated portion of former treatment system wells 231EW01 through 23EW07, 2311W02, 231IW04, 231IW05, 231IW07, 231IW08, and 231IW09 (Figure 2-2 in *MW, 1998b*). Detailed information on ORC® installation and monitoring is included in the Building 207/231 Area Annual Summary Report, October 1997 through July 1998 Quarterly Monitoring Periods (*MW, 1999a*), as well as in quarterly groundwater monitoring reports.

In 1999, Montgomery Watson prepared a Draft Final Building 207/231 Area Corrective Action Plan (*MW, 1999b*). This document summarized most, but not all of the previous data, developed correction screening objectives and screening levels, developed remedial alternatives, and proposed specific remedial alternatives for soil and groundwater. In addition, the MW Draft CAP included a statistically-based decision analysis that attempted to incorporate stakeholder input into the decision-making process and statistically evaluate the input. However, the Draft MW CAP was viewed by stakeholders as incomplete and was not implemented.

CalTrans Investigation – CalTrans is currently investigating and planning for the reconstruction of the Doyle Drive overpasses that pass through the Building 207/231 Area. For the part of the investigation that passes through the 207/231 area, consultants for CalTrans installed the nested Wells HGB2-20, HGB2-40, and HGB2-71, Boring CPT-5, and the nested Wells HGB3-28, HGB3-64, and HGB3-74 in January 2001 and Observation Well OW-1 in June 2002 at the locations shown on Plate 5. Aquifer tests for hydraulic conductivity were performed in August 2002. The aquifer parameter results are under discussion. During the aquifer testing, groundwater samples were collected from Wells OW-1 and HGB3-28, and analyzed for TPH as diesel, TPH as gasoline, BTEX, and MTBE. None of the listed compounds were detected above reporting limits.

Data Gaps Investigation – The Data Gaps Investigation conducted at the Building 207/231 Area in 2004 was performed to address data gaps identified from review of chemical, hydrogeologic, and historical data collected during the previous investigations summarized above. Previous investigation results indicated that soil and shallow groundwater in specific areas had been affected with petroleum hydrocarbons and petroleum-related chemicals. These data gaps were addressed to further characterize the nature and extent of chemicals in soil and groundwater at the Site and provide additional data needed to support the preparation of this CAP. Field work consisted of a geophysical investigation to investigate potential UST locations, drilling 34 soil borings, collecting soil and groundwater samples from the borings, and analyzing the samples for various chemicals compounds. The results of the investigation have been

incorporated into Section 3.4 to characterize the nature and extent of chemicals in soil and groundwater at the Site (*MACTEC, 2004a, c*).

3.3.4 LTTD Soil

In 1995, the Army investigated using low temperature thermal desorption (LTTD) to treat petroleum hydrocarbon contaminated soil from the various tank removal and excavation activities being conducted through out the Presidio (*MW, 1995b*). An onsite LTTD facility was constructed at the Commissary area west of the 207/231 Area during the Fall of 1995; contaminated soil storage began in November 1995, and treatment of soil began on July 1, 1996 and continued through July 31, 1997 (*MW, 1998b*). After treatment, the soil was placed in discrete piles and analyzed for TPH and PAHs using immunoassay tests that had been previously calibrated with laboratory analytical tests. Some laboratory analytical tests were also performed for continuing confirmation of the immunoassay results. The treatment analytical "batch" test results for most but not all of the piles are documented in the final project report (*MW, 1998b*).

LTTD treated soil was used to backfill the 1996 UST 207 excavation, as discussed in Section 2.4.2. Documentation of LTTD soil uses for the time period of the excavation for FDS Pipeline Section BR10-1 adjacent to Building 228 were located and reviewed. The documentation included the next three backfilled excavations on the FDS pipeline further south on Halleck Street. However, no documentation was noted of which LTTD-treated soil piles were used for the excavation adjacent to Building 228. It is believed that the source pile documentation does not exist.

3.3.5 Remedial Activities

In 1990, a combined soil vapor-ground water extraction and treatment system was installed on the north side of Building 231 near the former USTs (*ELM and Martech, 1991*). The system included a total of seven combination vapor and groundwater extraction wells (EW-series) and 11 injection wells (IW-series), shown on Plate 8. Testing of the system started on July 24, 1990 (*Army, 1990, 1993a*).

Malfunctions of the treatment unit started almost immediately requiring repairs and subsequent startup testing and startup activities continued until about November 5, 1992 (*Army, 1993b*). In addition, the final permits for operation were not acquired until December 22, 1993. System operations reportedly began on January 25, 1993, and continued to March 1, 1993, and then from March 24, 1993, to at least June 3, 1993. Reportedly, the vapor concentrations were causing the groundwater treatment portion of the treatment system to automatically shutdown because the vapor concentrations were exceeding the lower explosive limit (LEL). Consequently, only the soil vapor extraction and treatment (SVET) portion of the system was operated after April 20, 1993, with the intention of reactivating the groundwater treatment portion of the system after the vapor concentrations decreased to below the LEL.

The December 30, 1993, quarterly letter report covered the time period from September 20 to December 20, 1993 and referred to earlier activities (*Army, 1993b*). The petroleum hydrocarbon concentrations of the inlet soil vapor had decreased from 12,000 parts per million (ppm) on April 14, 1993, to 1,667 ppm on October 18, 1993. Between September 20 to December 20, 1993, the SVET system was in operation only for periods of a day or less for test purposes. With the decreased vapor concentrations, the groundwater portion of the treatment system was made operable, and approximately 250 gallons of groundwater were removed and treated between October 28 to December 20, 1993. The quarterly letter report discusses the decreasing concentrations and notes that additional soil analytical tests will be performed to pursue closing the Site.

Documentation of treatment system operations after December 20, 1993, has not been located and it is unclear how much longer the system was operated. As noted above in Section 3.3.3, RI activities began in 1990 and have continued to the present. As discussed in Section 3.4, the most recent concentrations of petroleum hydrocarbons in soil and groundwater confirm that the treatment system did not achieve concentrations that would enable site closure under current action levels.

3.3.6 Groundwater Monitoring

Various monitoring wells and piezometers have been installed at the Site since 1988. Table 2 summarizes all of the wells installed within the Site boundaries, including those subsequently abandoned or destroyed, when installed, well construction details, and the current status. Plate 5 shows the locations of monitoring wells. The quarterly monitoring program for groundwater in the Building 207/231 Area began in July of 1993 and has continued to the present (*T&R, 2005*). The ~~most recent available~~ monitoring data is from the December 2004 monitoring event (*T&R, 2005*).

3.4 Source, Nature, and Extent of Chemicals in Soil and Groundwater

As summarized above, numerous investigations have been conducted at the Site, generating a large amount of data. However, previous investigations did not consolidate and consider all available soil and groundwater data. The Data Gaps Work Plan (*MACTEC, 2004a*) consolidated all of the data available at that time, described the nature and extent of contamination based on that available data, developed screening levels using the most conservative action levels from among petroleum hydrocarbon, freshwater, salt water, and human health goals, and identified data gaps. The Data Gaps Investigation acquired the additional data necessary to fill those data gaps in support of the preparation of this CAP (*MACTEC, 2004c*). In addition, the ongoing Presidio-wide quarterly monitoring program generates additional data, including the sampling and analyses of wells in the Building 207/231 Area (*T&R, 2005*).

The following sections describe the current Site conditions incorporating data through and including the December 2004 groundwater monitoring event, followed by the site conceptual model. The nature and extent is organized by each specific source from south to~~the~~ north, and then subdivided by tank product, chemicals in soil, and chemicals in groundwater. The screening levels used in the Data Gaps Investigation are referenced solely to highlight where chemical concentrations are relatively higher. The Site-specific cleanup levels that are used to define the remedial units requiring assessment of the need for

corrective action are developed and presented in Section 4.2. Appendix A contains a CD disk with all available soil and groundwater chemical data, respectively. To assist in visualizing the extent of chemicals, chemical data is posted on Plates 11a, 11b, 12a, and 12b, as referenced below.

3.4.1 Former Section BR10-1 of FDS Pipeline and Potential Fuel Oil Tank at End of FDS Pipeline in Building 228

Section BR10-1 of the FDS pipeline adjacent to Building 228, shown on Plate 5, was abandoned sometime prior to November 1975, and removed in August 1996 (*IT, 1999b*). During the removal, eight soil samples were collected from the section of pipeline adjacent to Building 228, and analyzed for TPH in the diesel and fuel oil range, and PAHs. Sample FB1001W01 contained TPH in the diesel range at 2,500 mg/kg and in the fuel oil range at 2,400 mg/kg, both above the Data Gaps Investigation diesel and fuel oil screening levels of 115 and 144 mg/kg, respectively. No PAH screening levels were exceeded. Sample FB1001W01 represented soil left in place because the presence of Building 228 prevented further excavation. The IT report presented a cross section indicating the north face of the excavation had three fuel oil stains: one stain of approximately 3 feet in diameter, and two stains of less than 1 foot in diameter. It is unknown how far the fuel oil affected soil extends beneath Building 228. However, the visual and analytical results suggest that the release was small and migrated less than 5 feet.

Groundwater was not encountered during the excavation activities. Well 231GW04, located downgradient of Building 228 and sampled quarterly from December 5, 1990, through October 11, 1996, did not detect TPH as fuel oil above the reporting limits.

As discussed in Section 3.3.4, the pipeline excavation adjacent to Building 228 was backfilled with LTTD-treated soil for which the analytical results have not been located and do not appear to exist. As discussed in the Data Gaps Investigation report, the soil sample collected from the LTTD soil at Boring 228SB100 did not contain PAHs at concentrations above screening levels (*MACTEC, 2004c*). Plate 11b posts the soil analytical results.

A circular tank, presumably used to store fuel oil, may still be present under the floor inside Building 228. The FDS Pipeline removal report did not discuss what, if anything was done at the end of the Section BR10-1 Pipeline. Therefore, this location will need to be investigated for the possible presence of a fuel oil UST. As discussed above, Well 231GW04, located downgradient of Building 228 and sampled quarterly from December 5, 1990, through October 11, 1996, did not detect TPH as fuel oil above the reporting limits.

3.4.2 Former USTs 228.1, 228.2 and 228.3

Tank Product

Samples collected of the product in the USTs indicated that Stoddard solvent was the dry cleaning solvent used. Stoddard solvent is a petroleum hydrocarbon that gives a gas chromatographic pattern similar to jet fuel. Stoddard solvent is a petroleum distillate mixture of C7 to C12 hydrocarbons and may include variable concentrations of aromatic hydrocarbons such as toluene, ethylbenzene, and xylenes. Sample 228FP02, collected from the product in UST 228.2 and analyzed only for BTEX, contained 200 mg/kg each of toluene and ethylbenzene, 900 mg/kg of total xylenes, and less than 50 mg/kg of benzene (the results were reported as mg/kg). Sample 228TK02 was collected from the product in the UST 228.3, and consisted of TPH (range unspecified) at 1,000,000 mg/kg, toluene at 700 mg/kg, ethylbenzene at 300 mg/kg, and total xylenes at 1,000 mg/kg (*D&M, 1997*). Sample 228.1, collected from the product in UST 228.1, had 1,000,000 mg/L of TPH in the gasoline range but with the chromatographic pattern not consistent with gasoline. The sample also contained 7,100 mg/L of xylenes; benzene, toluene, and ethylbenzene were below the reporting limit of 0.005 mg/L.

Soil samples collected adjacent to the USTs from Borings 228SB2 and 228SB3 also detected tetrachloroethene (PCE), 1,2-dichlorobenzene (1,2-DCB), and 1,4-dichlorobenzene (1,4-DCB) at maximum concentrations of 0.0054, 0.017, and 0.0034 micrograms per kilogram (µg/kg), respectively. This suggests that although Stoddard solvent was the primary dry cleaning solvent used at the time the

USTs were tested, other chlorinated solvents such as PCE may have previously used in smaller quantities or as stain removers. DCB is known to have been used as a degreaser but is not commonly associated with the dry cleaning industry.

Soil

During the Data Gaps Investigation, soil and groundwater samples were collected from Soil Borings 228SB101 and 228SB102 in the former UST excavation to assess current chemical concentrations, which are posted on Plate 11b. TPH in the range of gasoline, diesel, and fuel oil, ethylbenzene, total xylenes, arsenic, cadmium, chromium, lead, nickel, and zinc were detected above reporting limits. As discussed in the Data Gaps Investigation, TPH in the gasoline and diesel range exceeded screening levels. In previous investigations, ethylbenzene, total xylenes, PCE, 1,2-DCB, and 1,4-DCB were also detected in soil at concentrations above reporting limits. Based on the analytical results and the screening levels, additional remediation in the area between the former excavation and the historic wall will be required. The analytical results from soil borings around this area suggest that lateral migration is unlikely to have occurred. Some minor migration may have occurred to the north but treatment for petroleum hydrocarbons in the area at UST 231.2 is already proposed, as discussed below.

Groundwater

During the Data Gaps Investigation, groundwater samples were collected from Soil Borings 228SB101 and 228SB102. TPH as gasoline and as unknown gasoline hydrocarbons, 1,2-DCB, and nickel were detected at concentrations above screening levels, indicating that residual Stoddard solvent is present in groundwater at the location of the former Stoddard solvent USTs. TPH as fuel oil and unknown diesel hydrocarbons, toluene, total xylenes, and arsenic were also detected at concentrations above reporting limits but below screening levels.

Monitoring Well 231GW04 is located downgradient of USTs 228 and had been sampled quarterly from December 5, 1990, through October 11, 1996. TPH as gasoline was last detected on October 11, 1996, at 590 μg/L, above the screening level of 443 μg/L. As discussed above, the carbon range for Stoddard solvent is from C7 to C12, the same range as gasoline. However, the quarterly monitoring results do not mention whether the chromatographs were compared to a Stoddard solvent standard and the gasoline UST 231.2 was located within 6 feet of Well 231GW04. The analytical results discussed for UST 231.2 below suggest that gasoline is the more likely cause of the gasoline-range detections. In any case, further remediation will be needed for the UST 231.2 area, as discussed below.

3.4.3 Former UST 231.2

Tank Product

Historical records indicate this UST contained gasoline. Sample 231TK01 was collected from the product in the UST and consisted of TPH (range unspecified) at 1,000,000 mg/kg, benzene at 6,000 mg/kg, toluene at 20,000 mg/kg, ethylbenzene at 10,000 mg/kg, total xylenes at 30,000 mg/kg, and chloromethane at 500 mg/kg (the results were reported as mg/kg) (*D&M, 1997*). Since the UST was removed in 1988, it is unlikely that MTBE was present as an additive. This area is located behind Building 231 between the building and the historical wall near Building 228. The area currently, and presumably historically, stores miscellaneous equipment. Therefore, some heavier petroleum hydrocarbons in the diesel and oil range may have been released here as well, as discussed below.

Soil

Soil containing TPH in the ranges of gasoline, diesel, and fuel oil, and the metals arsenic, chromium, lead, and zinc at concentrations above screening levels were detected in this area, as posted on Plate 11b. The UST was reported to have stored gasoline. The heavier range petroleum hydrocarbons may be associated with the cleaning operations of Building 231, the storage of equipment between Building 231 and 228, or

the hydraulic lifts within Building 231. As discussed in the Data Gaps Investigation report, the area around UST 231.2 is within a larger area that exceeded screening levels. Plate 11b illustrates the area with higher concentration contours of both gasoline and diesel/fuel oil range petroleum hydrocarbons surrounding the UST 231.2 area. The area includes the location of Soil Boring 231SB64 because, although soil samples at 2 and 3.5 feet bgs did not exceed screening levels, the boring log indicated the 2.75 foot depth interval with free product was not sampled.

Soil samples were collected beneath Building 231 at former Hydraulic Lifts H1 through H6, located downgradient of the former UST 231.2. The analytical results from samples collected at the lifts indicate that TPH as gasoline has migrated from the former fuel tank through the locations of the lifts beneath the building. The analytical data for the hydraulic lift samples is discussed below in Section 3.4.5.

The area west of the former UST 231.2 was further explored during the Data Gaps Investigation by the collection of soil samples from Soil Borings 231SB100 and 231SB101. TPH as gasoline was not detected at concentrations above screening levels, indicating that gasoline from UST 231.2 has not migrated further west of Building 231. However, TPH as fuel oil and in the unknown diesel range were detected at concentrations above screening levels in Soil Boring 231SB101. The area to the east of former UST 231.2 is discussed with former UST 231.1 in Section 3.4.4 below.

Groundwater

The only groundwater sample at the former location of UST 231.2 was collected on March 14, 1997, for the HydroPunch groundwater sample at 231HP05. TPH as gasoline and benzene were reported at 1,300 and 5.8 μg/L, respectively, with both concentrations exceeding screening levels. Groundwater samples previously collected at Well 231GW04 and 228HP1 also had screening level exceedances for gasoline, diesel, and/or fuel oil range petroleum hydrocarbons. These analytical results, along with the analytical results from the hydraulic lift removals inside Building 231 discussed in Section 3.4.5 below, indicate that

petroleum hydrocarbons in groundwater extend from former UST 231.2 to beneath the slab for Building 231.

The area west of the former UST 231.2 was further explored during the Data Gaps Investigation by the collection of groundwater samples from Soil Borings 231SB100 and 231SB101. TPH as gasoline was detected at 320 μg/L in Boring 231SB100 and was not detected above the reporting limit in Boring 231SB101. Both results are below screening levels. However, TPH in the unknown diesel range was detected in Boring 231SB100 (550 μg/L) and Boring 231SB101 (1,900 μg/L); both concentrations are above the 443 μg/L screening level. The area to the east of former UST 231.2 is discussed with former UST 231.1 in Section 3.4.4 below.

3.4.4 Former USTs 231.1

Tank Product

Historical records indicate this UST contained waste oil.

Soil

Soil in this area is included in the area presumed to be above screening levels due to the observation of visually-contaminated soil during the UST removal (*IT, 1997b, 1998*) and due to the groundwater analytical results discussed below. In addition, the analytical results from soil samples collected at former Lift H6, discussed below in Section 3.4.5, indicate that some of the waste oil has migrated to the former location of Lift H6, especially as indicated by the presence of PCB 1016 at both locations.

Groundwater

TPH as gasoline, diesel, and fuel oil, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, Arochlor 1016, lead, nickel and zinc were detected in a grab groundwater sample 231GW112 collected from the excavation at concentrations above screening levels.

As discussed in Section 3.4.5 below, PCB 1016 has migrated from this former UST to the location of former Lift H6 at a concentration above the screening level. Although not above the screening level, gasoline appears to have also migrated to the location of former Lift H6.

Groundwater samples were collected from Borings 231SB104 and 105, located downgradient of former UST 231.1 and Lift H6. Plate 9~~b~~ lists the various TPH compounds, PAHs, VOCs, and metals detected at these two boring locations. The chemicals compounds detected at Boring 231SB104 may be mixed with the release from the former USTs 231.4 through 231.7 and/or their fuel islands. The TPH compounds detected at Boring 231SB105 are probably entirely from the former UST 231.1 and Hydraulic Lift H6.

3.4.5 Hydraulic Lifts H1 through H6

Lift Product

The cylinders of the hydraulic lifts contained hydraulic oil.

Soil and Groundwater

Soil and groundwater samples were collected adjacent to the hydraulic lifts at the locations shown on Plate 5. The analytical results are posted on Plates 11b and 12b.

At Lifts H2, H3, and H5, the soil and groundwater analytical results indicate the presence of fuel oil range petroleum hydrocarbons at concentrations above screening levels. The carbon range of hydraulic oil is typically within the same range as fuel oil. In addition, gasoline- and diesel-range petroleum hydrocarbons are present, although the laboratory report indicates the gas chromatograph patterns do not match gasoline or diesel standards. Lifts H2 and H3 are immediately downgradient of former gasoline UST 231.2. This suggests that the release from the former gasoline UST has migrated through the area of Lifts H2 and H3 and possibly north to the area of former USTs 231.4 through 231.7.

At Lift H6, the soil and groundwater analytical results indicate TPH in the fuel oil range as the dominant petroleum hydrocarbon released with lesser concentrations of gasoline and diesel range petroleum hydrocarbons. In addition, arsenic, copper, lead, nickel, zinc, and PCB 1016 were detected above screening levels in soil; PCB 1016, bromobenzene, lead, and zinc were detected in groundwater at concentrations above screening levels. The suite of chemicals detected at Lift H6 and the proximity of Lift H6 to the former waste oil UST 231.1 suggests that chemicals from the release associated with former UST 231.1 have migrated through the area of Lift H6. As discussed above, Arochlor 1016 was detected further downgradient at Boring 231SB105, indicating that chemicals have migrated from former UST 231.1 to Lift H6 to Boring 231SB105. The borings located further downgradient (231SB04, 231SB07, 231SB08, 231SB49, 231SB50, and 231SB51) have fewer chemicals detected and at lower concentrations, suggesting that the chemicals from former UST231.1 and Lift H6 have not migrated beyond Boring 231SB105. It is possible that some fuel oil range petroleum hydrocarbons have migrated further to the area of the historically visibly stained area. However, as discussed in Section 3.4.7, the former visibly stained area is to be remediated due to chemicals detected there.

3.4.6 Former USTs 231.4 through 231.7 and Potential Eastern USTs

Tank Product

Historical records indicate these USTs contained gasoline. Since the last USTs were removed in 1988, it is unlikely that MTBE was present as an additive. As shown on Plate 5, two USTs were present from 1949 to 1950, located at the northeastern corner of the more recent fuel island, and the four USTs 231.4 through 231.7 were removed in 1988. The geophysical search during the Data Gaps Investigation indicated that the two USTs installed in 1941 are no longer present.

Soil

Plate 11b shows the locations of soil samples with chemical concentrations that exceeded at least one screening level in the area around the former Building 231 gasoline USTs. To illustrate the area affected by the release of petroleum hydrocarbons, gasoline, diesel, and benzene concentrations contours have been added to Plate 11b. The area within the contoured area includes the former USTs 231.4 through 231.7 and their associated fuel islands, and the area of the previous 1941 gasoline station. This suggests the known location of the 1941 to 1950 USTs may have contributed to the petroleum hydrocarbon release in soil in this area. The area within the contours also extends downgradient to within the area of Gorgas Avenue. Soil samples from Borings 231SB111, 231SB112, and 231SB113, located further downgradient under the Doyle Drive/Highway 101 overpass, did not detect gasoline above reporting limits, indicating that gasoline has not migrated in soil to under the Doyle Drive/Highway 101 Overpass. However, soil at Borings 231SB111, 231SB112, and 231SB113 detected fuel oil and unknown diesel at concentrations above screening levels. It is unknown whether the heavier petroleum hydrocarbons migrated from the Building 231 area or were released directly beneath the Doyle Drive/Highway 101 overpass.

The extent of the gasoline and associated benzene release from the former Building 231 USTs is bounded on the west by the lack of gasoline and benzene detections at Borings MT#1, 231SB17, 231SB31, 231SB109, and 231SB110, and on the south by Borings 231SB03, 231SB102, 231SB103, and 231SB116. The extent is partially bounded on the east by Borings MT#5, 231SB04, 231SB15, 231SB45, 231SB47, 231SB48, 231SB114, and 231SB115. The extent of heavier-end petroleum hydrocarbons in soil southeast of the former Building 231 fuel islands may merge into the historically visibly stained area, as contoured on Plate 11b.

As shown on Plate 11b, Borings 231SB29 through 231SB31, located outside of the area of petroleum hydrocarbon screening level exceedances, had soil samples at 1 or 4 feet bgs with lead concentrations ranging from 53 to 120 mg/kg, just above the lead screening level of 50 mg/kg. The absence of

petroleum hydrocarbon exceedances suggests that the lead may not be from the UST fuel release. It is possible that the lead is due to the presence of the adjacent Doyle Drive/Highway 101 overpasses, or to fill materials used to fill in the former marsh or construct Gorgas Avenue.

Groundwater

During the Data Gaps Investigation, the groundwater within the former UST 231.4 through 231.7 excavation was sampled at Boring 231SB108 and confirmed the presence of gasoline as high as 2,900 mg/kg at 7 feet bgs, along with maximum concentrations of 18 μg/kg benzene, 23 mg/kg ethylbenzene, 13 mg/kg total xylenes, 450 mg/kg TPH as diesel, and 820 mg/kg TPH as fuel oil. Various chemical concentrations exceeded screening levels, despite the previous 1988 excavation and 1993 soil vapor extraction remedial actions.

For the August 2003 and March 2004 monitoring events, Wells 231GW21, 231GW22, 231PZ01, 231PZ02, 231PZ03, and 231PZ04, located in Gorgas Avenue downgradient of the former Building 231 USTs and the fuel islands, were sampled and detected TPH as gasoline and benzene at concentrations exceeded screening levels, as shown on Plate 12b. Ethylbenzene, toluene, and total xylenes were also detected in some of these wells at concentrations above screening levels. The analytical results of groundwater samples collected during the Data Gaps Investigation indicate that gasoline has not migrated downgradient to beneath the Doyle Drive/Highway 101 overpass as indicated by the lack of gasoline detections in Borings 231SB111 through 231SB114. TPH in the gasoline range was detected at Boring 231SB110, at 200 μg/L, below the screening level of 443 μg/L. This detection probably represents a residual weathered gasoline from the former Building 231 USTs.

Plates 13 and 14 present the historic TPH as gasoline and diesel concentrations in groundwater, respectively, in the Shallow Sand aquifer. Overall, the concentrations of TPH as gasoline and diesel have decreased with time. Plates 15 and 16 present the historic TPH as gasoline and diesel concentrations in groundwater, respectively, in the Upper Intermediate Sand aquifer. With the exception of a few

concentration spikes, TPH as gasoline has not been detected in the Upper Intermediate Sand. The history of TPH as diesel concentrations are mostly non-detect results, but with more concentration spikes. However, an examination of the analytical results reveals that the results were qualified as not resembling the diesel standard and as estimated values below the reporting limit. The qualifications suggest that the Upper Intermediate Sand likely does not reliably have diesel range petroleum hydrocarbons.

The extent of gasoline on groundwater from the former Building 231 USTs are bounded on the west by Borings 231SB109 and abandoned Well 231GW02; on the south (upgradient) by Borings 231SB102, 231SB116, and 231SB103; and to the east by Borings 231SB114 and 231SB115. To the southeast at the southeastern corner of the former fuel islands and Boring 231SB104, TPH as gasoline and an unknown diesel, benzene, 1,2-DCB, and various PAHs were detected as shown on Plate 12b. As previously discussed, the release of gasoline from the former Building 231 USTs may have merged with the releases from former UST 231.1 and Hydraulic Lift H6.

As discussed in Section, 3.1.1, the excavation for USTs 231.4 through 231.7 extended through the Fill, Shallow Sand, and the Shallow/Intermediate Aquitard units, and reached the top of the underlying Upper Intermediate Sand. However, the distribution of petroleum hydrocarbons in groundwater in the Building 231 area is limited to the shallow aquifer zone, as indicated by the detections of petroleum hydrocarbons in the above-listed Wells 231GW21, 231GW22, 231PZ01, 231PZ02, 231PZ03, and 231PZ04, all screened in the Shallow Sand. TPH as gasoline, diesel, and fuel oil have never been detected in Intermediate Sand Well 231GW26, located immediately downgradient of the former Building 231 USTs; TPH as gasoline was detected in groundwater during one sampling event at Intermediate Sand Well 231GW15, located further downgradient of the former USTs. This is because of the upward hydraulic gradient from the Intermediate Sand to the Shallow Sand, discussed in Section 3.1.2, and because the chemicals released are petroleum hydrocarbons that do not tend to sink.

3.4.7 Historically Visibly Stained Area

As discussed in the Data Gaps Investigation, a visibly stained area was visible just west of Building 230 in the 1948 aerial photograph. Analytical details for the historically visibly stained area between Buildings 230 and 231 are summarized below:

At Borings 231SB49, 231SB50, and 231SB66, soil screening levels were exceeded for TPH as fuel oil down to 2.7 feet bgs.

At Boring 231SB07, Total Recoverable Petroleum Hydrocarbons (TRPH) were detected at 400 mg/kg at 2.5 to 3.1 feet bgs (*Stollar, 1992*). At Boring 231SB04, TRPH was detected at 100 mg/kg at 2.2 to 3.2 feet bgs. These concentrations exceed all gasoline, diesel, and fuel oil screening levels. Although TRPH is not the optimal analytical method, the data was still considered.

Boring 231SB65 had 9.8 (J+) mg/kg TPH as gasoline, 43 mg/kg TPH as diesel, and benzene at 0.027 mg/kg at 3.5 feet bgs. The benzene concentration exceeds the screening level of 0.005 mg/kg. Boring 231SB65 also had 19 mg/kg TPH as diesel and 82 mg/kg TPH as motor oil at 1-foot bgs (Table 2 in *IT, 1997b*). However, the boring log notes "intense" petroleum hydrocarbons odor at 2.75 feet with groundwater encountered at 2.5. The samples may not have been collected at the depth with the highest concentrations. Therefore, this area was included in the area exceeding screening levels and remediation in this area should be considered.

During the Data Gaps Investigation, soil samples collected at Boring 231SB106 and 231SB107 (Plate 5) confirmed the presence of TPH in the fuel oil range petroleum hydrocarbons in shallow soil in this area at 2,000 and 210 mg/kg, respectively (*MACTEC, 2004a, b*).

The northern extent to beneath Gorgas Avenue is unknown. Based on the 1948 aerial photograph, the petroleum hydrocarbons associated with the historically visibly stained area are not anticipated to extend beneath Gorgas Avenue. The extent of the heavier petroleum hydrocarbons is bounded on the west as

shown on Plate 5 at Borings 231SB06, 231SB47, 231SB15, 231SB45, 231SB48, and 231SB04. The groundwater sample from Boring 231SB106 detected 65 μg/L of TPH in the unknown diesel range, below the screening level *(MACTEC, 2004a, b)*.

3.4.8 Building 230 Railroad Spur

Building 230 has a loading dock along the east side of the building. Rail cars would have been temporarily parked to load and unload goods. Building 230 has no record of industrial or manufacturing use. The presence of the parked rail cars may have resulted in incidental spillage of diesel fuel, oil, or grease to shallow soil beneath the rail cars along the track.

Soil samples have been collected from three soil borings as deep as 10 feet bgs (the depth to saturated soil) located along the rail spur, as shown on Plate 11b. TPH in the fuel oil and diesel range, lead, and several PAHs were detected at the concentrations posted on Plate 11b. The detection of these chemicals are consistent with the presence and use of rail cars. Screening levels were exceeded for TPH, lead, and some PAHs. ~~The~~ Lead and PAHs were only detected above screening levels in the sample collected at 3 feet bgs, and were not detected in deeper samples ~~number of chemicals detected and the reported concentrations decrease with depth~~, indicating these chemicals are limited to shallow soil. TPH as fuel oil or diesel was not detected in the samples collected at 3 or 10 feet bgs above screening levels, but was detected above these levels in the sample collected at 5.5 feet bgs. Groundwater was not sampled in this area; however, soils were sampled until saturated soils were encountered at 10 feet bgs, and no COCs were detected above cleanup levels.

3.4.9 Former Building 271 Garage

Potential Chemicals Released

The former garage is anticipated to have used petroleum products such as gasoline, diesel, oil, grease, and metals. Consequently, activities at the former garage may have resulted in residual spillage of petroleum hydrocarbons such as gasoline, diesel, and oil and grease, and metals, such as cadmium, chromium, lead, nickel, and zinc. PAHs might have also been released as a part of any residual diesel and oil spillage.

Soil

The soil analytical results from the sample collected at Boring 271SB100 ~~01~~ are posted on Plate 11a. The detected chemicals include TPH as diesel and fuel oil, the metals arsenic, cadmium, chromium, lead, nickel, zinc, and various PAHs. Only lead and zinc at 2 feet bgs and benzo(a)pyrene at 5 feet bgs exceeded screening levels.

Groundwater

The groundwater analytical results from the sample collected at Boring 271SB01 are posted on Plate 12a. The detected chemicals include the metals arsenic, cadmium, chromium, and nickel, and various PAHs. Screening levels were exceeded for benzo(a)anthracene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, and chrysene.

3.4.10 Sump 208

Sump Contents

As discussed in Section 3.3.2, Sump 208 was a sand and oil-water separator that upon removal was observed to have a black, odorous, oily sand beneath the bottom that was excavated and disposed offsite.

This sump probably would have received the full range of petroleum hydrocarbons from gasoline through oil and grease from the washing of vehicles.

Soil

Soil analytical data for the Sump 208 area is posted on Plate 11a. Soil Sample S-3, collected at 5 feet bgs from the black, odorous, oily sand, contained 7,400 mg/kg of TPH in the diesel range, above the screening level of 115 mg/kg. Soil samples S-1 and S-2, located south and north of Sample S-3~~1~~, respectively, did not exceed gasoline or diesel screening levels. During the Data Gaps Investigation, soil samples were collected from Boring 208SB100 to investigate deeper soil. The results for soil samples at 6 and 7.5 feet bgs detected TPH as fuel oil and diesel, the metals arsenic, cadmium, chromium, lead, nickel, and zinc, and various PAHs. Only the TPH as fuel oil at 6 feet exceeded the screening level. The results for the soil sample collected at 10 feet detected TPH as diesel, the metals arsenic, cadmium, chromium, lead, nickel, and zinc, and two PAHs. No screening levels were exceeded.

Groundwater

Groundwater analytical data for the Sump 208 area is posted on Plate 12a. During the Data Gaps Investigation, a groundwater sample was collected from Boring 208SB100. The results for the groundwater samples detected TPH as diesel, the metals arsenic, cadmium, and nickel, and various PAHs. Nickel and the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd) pyrene were detected at concentrations above screening levels.

3.4.11 USTs 207.1, 207.2 and 207.3

Tank Product

Historical records indicate these USTs contained gasoline and were present from 1982 to 1996. Because the USTs were used until 1996 and as confirmed by soil and groundwater sample data discussed below, MTBE was a component of the gasoline.

Soil

Soil analytical data for the Building 207 area is posted Plate 11a. TPH as gasoline, benzene, toluene, ethylbenzene, total xylenes, and MTBE were detected in soil samples collected both during the 2004 Data Gaps Investigation and during previous investigations. TPH as gasoline and benzene were detected as high as 1,100 mg/ kg~~20,000 µg/L~~ and 1 mg/kg~~60 µg/L, respectively,~~ at Borings 207EX12 and 207EX14~~231SB105~~, respectively, sampled in 2004 along the southern border of the 1996 excavation. Although excavation remedial actions were performed in 1996 and 1998, some soil with petroleum hydrocarbons was not excavated. As shown on Plate 11a, the two excavations did not adequately meet on their common boundary and the 1996 excavation did not extend far enough to the south or east. Most of the current cleanup level exceedances in this area are the result of changes in~~current~~ screening levels since the time~~that are lower than when~~ the excavations were performed. The soil sample analytical results suggest that petroleum hydrocarbons in soil do not extend very far beyond the previous excavation areas. ~~Plate 11a shows the location of surrounding borings where petroleum hydrocarbons were not detected.~~

As discussed in Sections 3.3.3 and 3.3.4, the 1996 excavation was backfilled with LTTD soil. As discussed in the Data Gaps Investigation, two of the soil piles used as backfill for the 1996 excavation contained 0.043 and 0.122 mg/kg benzo(a)pyrene, exceeding the most conservative screening level of 0.027 mg/kg. LTTD soil was not used to backfill the 1998 excavation.

As discussed in Section 3.3.2, a concrete-encased, fiber optic conduit passes through the 1998 excavation. The soil beneath the conduit was not removed because the conduit was believed to be too fragile. Therefore, a small volume of soil with petroleum hydrocarbons above screening levels may still be present beneath the conduit. Conservatively assuming the volume of soil remaining to be a maximum of 1 feet wide by 5.5 deep [depth to groundwater at that time] minus 2 feet [the apparent depth of the conduit] by 114 feet long, the volume of soil is assumed to be ~~no more than~~approximately 20~~15~~ cubic yards (cy). Considering this relatively small volume of soil is currently beneath Mason Street and assuming the street will remain for the foreseeable future, ~~the presence of the soil may not pose an unacceptable risk. N~~no further investigation is proposed at this time.

Groundwater

As shown on Plate 11a, various groundwater monitoring wells, piezometers, and HydroPunch borings are located in and downgradient of the UST 207 area. Quarterly groundwater monitoring of all wells and piezometers in the Building 207 area has been discontinued except for Well 207GW03. Gasoline, diesel, fuel oil, and VOCs, except for carbon disulfide, were not detected above reporting limits. Carbon disulfide was detected at 1.5 µg/L, but is a naturally-occurring compound commonly detected in marsh environments.

To assess current groundwater conditions, groundwater samples were collected during the Data Gaps Investigation at Borings 207HP100 through 207HP103, 207SB104, and 207SB105. The results are posted on Plate 12a and concentration contours have been added for gasoline, benzene, and MTBE. Gasoline and benzene were still present at concentrations as high as 2,100 and 3.4 µg/L, respectively, at Boring 207SB105, located along the southern edge of the former fuel islands and 1996 excavation. At Boring 207HP100, MTBE was detected as high as 1,400 µg/L, along with 560 µg/L of an unknown diesel range TPH and 17 µg/L of toluene.

3.4.12 Former Building 38 Area

Tank Product

No records of USTs or above-ground fuel or oil storage tanks are known to exist. However, as discussed in Section 3.2, historical records indicate the former Building 38 buildings were identified as an oil station and later as a gas station. Therefore, various fuels and oils are assumed to have been used and stored in or adjacent to the buildings.

Soil

During the Data Gaps Investigation, soil samples were collected from Borings 38SB100 through 38SB103, oriented in a line along the reported former locations of the buildings. The analytical results are posted on Plate 11a. Various PAHs, TPH as fuel oil and in the diesel range, and metals were detected in soil samples from all four borings. The number of compounds detected and the concentrations decreased with depth. In addition, chemicals with concentrations exceeding screening levels occurred predominantly in shallow soil samples from the middle two borings. This suggests that the majority of releases that occurred in the Building 38 area occurred at or near Building 38-A and the Garage.

Groundwater

During the Data Gaps Investigation, groundwater samples were collected from Borings 38SB100 through 38SB103, oriented in a line along the reported former locations of the buildings. The analytical results are posted on Plate 12a. Various PAHs, toluene, and metals were detected in groundwater samples from all four borings. In addition, 1,2-DCE were detected in the northern Borings 38SB100 and 38SB101, and TCE and vinyl chloride were detected in the northernmost Boring 38SB100. As with the distribution of chemicals in soil discussed above, the number of compounds detected, the detected concentrations, and the number of screening level exceedances were higher in the center two borings (38SB101 and 38SB102) located at Building 38-A and the northern end of the Garage relative to the outer borings

(38SB100 and 38SB103). The detection of TCE and its biodegradation daughter products cis- and trans-1,2-DCE, and vinyl chloride in groundwater beneath Building 38 suggests the use of TCE as a cleaning solvent, even though TCE, 1,2-DCE, and vinyl chloride were not detected in the overlying soil samples.

3.4.13 Site Conceptual Model

Petroleum hydrocarbons and petroleum related chemicals have been released from USTs, associated piping, one sump, and related surface spillage in the Building 207/231 Area. The affected units include vadose zone soil and groundwater in the Fill and Shallow Sand units.

For the Building 228 and 231 area, soil and groundwater chemical concentration contour maps indicate that petroleum hydrocarbons released from source areas was carried northward with groundwater flow along the water table through permeable historic fill placed above the Bay Mud and occasional Shallow Sand units. This would account for contaminants present at depth (5 to 10 feet bgs) as far north as Doyle Drive. The extent of chemicals in vadose zone appears to extend to Gorgas Avenue and possibly beneath but not north of the Doyle Drive/Highway 101 overpasses. Groundwater samples were collected from Borings 231SB111, 231SB112, and 231SB113 indicate that petroleum hydrocarbons in groundwater extend only as far north as the southern border of the Southern Doyle Drive/Highway 101 overpass.

Historic groundwater data of the two Intermediate Sand wells downgradient of the Building 231 area USTs indicates that petroleum hydrocarbons were detected briefly within the Intermediate Sand, but concentrations decreased to non-detect after 2002 (Plates 15 and 16). This is probably due to the upward hydraulic gradient between the shallow and intermediate groundwater zones moving water from the intermediate zone into the shallow zone through the break in the Bay Mud aquitard where USTs 231.4 through 231.7 were previously located and removed.

The extent of petroleum hydrocarbons in soil in the Building 207 area is limited to small portions on the edges of the previous 1996 and 1998 excavations that were not extended far enough laterally to remove

all soil containing COCs above current cleanup levels. In groundwater, petroleum hydrocarbons, including MTBE, extend from the former Building 207 USTs downgradient north to Mason Street. Historical sampling of shallow monitoring wells located north of Mason Street in Crissy Marsh indicated concentrations of petroleum hydrocarbons were below action levels at that time and the sampling was discontinued.

Chemicals released to surface soil can be transported as suspended particulates or as a dissolved phase in surface water runoff, then discharged into surface water bodies through storm drains or sheet runoff. Chemicals can also migrate downward through the vadose zone soil column to shallow groundwater. These chemicals may also adsorb to soil particles as they migrate downward, depending on the chemical and the soil type. Therefore, at the source area, chemicals may be found throughout the soil profile. Once they reach shallow groundwater, the chemicals will migrate as a dissolved phase, in the direction of downgradient groundwater flow (northerly) to eventually discharge into San Francisco Bay. These compounds may migrate as a separate free phase or dissolved in groundwater, although free phase petroleum product has not been reported in any monitoring well during sampling at the Site. As the groundwater level fluctuates (in response to recharge or lack of recharge from rainfall) and as water is drawn upward by capillary forces in the soil, chemicals in groundwater can adsorb onto soil particles just above the water table in the capillary fringe. Even though the Shallow/Intermediate Aquitard was breached by the excavation at the former USTs 231.4 through 231.7, thus providing a potential conduit for downward vertical migration, concentrations have attenuated because of the upward hydraulic gradient from the Intermediate Sand to the Shallow Sand.

On the basis of this conceptual model, chemicals in the source areas would be expected throughout the soil profile and in shallow groundwater. Downgradient of the source areas, chemicals would only be expected in capillary fringe soil and in groundwater.

Based on the results of the Arsenic in Groundwater Tech Memo (*MACTEC, 2006*) that further evaluated the presence of arsenic in groundwater and its relationship to petroleum hydrocarbons, soil types, and groundwater chemistry at the Building 207/231 Area, and two neighboring CAP sites—the Building 1065 Area and the Commissary/PX Area, the following conclusions provide a framework for the conceptual model of the nature and extent of arsenic contamination in shallow groundwater at the site:

- Reducing conditions are present in shallow groundwater at the Building 207/231 Area;
- Petroleum releases appear to be a primary factor that creates reducing conditions favorable to dissolving arsenic from iron-oxide soil coatings into groundwater;
- Once the arsenic dissolves into groundwater, arsenic concentrations remain relatively stable over time; and
- When the petroleum source and reducing conditions abate, arsenic concentrations may tend to slowly decrease due to dilution, dispersion, and transport.

4.0 SUMMARY OF SITE RISKS

This section summarizes the Remedial Action Objectives, development of cleanup levels based on human health and ecological concerns, and soil and groundwater remedial units (areas where concentrations of chemicals of concern exceed cleanup levels).

4.1 Remedial Action Objectives (RAOs)

RAOs are statements of the general goals of an environmental cleanup. For the cleanup remedies to be conducted at the Building 207/231 Area, RAOs include the following:

- Protection of human health and the environment;
- Cost-effective cleanup of the Study Area consistent with its potential land use;
- Recycling excavated materials such as concrete and asphalt to the extent practicable;
- Compliance with State and Federal environmental laws;
- Consistency of the selected corrective action alternatives at the Study Area with the overall transformation of the Presidio into a national park site; and
- Preference for permanent (“clean closure”) remedies whenever practicable, cost-effective, and consistent with current or anticipated land use.

4.2 Development of Cleanup Levels

This section discusses cleanup levels that were developed and used to identify locations within the Building 207/231 Area that may require potential corrective action based on chemical concentrations measured in soil and groundwater during previous investigations at the Site.

Cleanup levels for petroleum-related constituents in soil and groundwater at the Presidio were originally developed in the Fuel Product Action Level Development Report (FPALDR; *MW, 1995c*). In Order No. 96-070 (*RWQCB, 1996*), the Regional Water Quality Control Board, San Francisco Bay Region (RWQCB) adopted the FPALDR soil cleanup levels as Site Cleanup Requirements (SCRs) for petroleum hydrocarbons and related constituents in soil at the Presidio. Since the issuance of the FPALDR and SCRs, cleanup levels for the Presidio have been proposed in the Development of Presidio-Wide Cleanup Levels for Soil, Sediment, Groundwater, and Surface Water, Presidio of San Francisco, California (Cleanup Level Document; *EKI, 2002; Table 7-6 Revised May, 2006*). This document was developed by the Trust in consultation with the National Park Service (NPS), the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), the RWQCB, the United States Environmental Protection Agency (USEPA), and community members of the Restoration Advisory Board (RAB). For petroleum-related constituents, the SCRs for soil are proposed as Presidio-wide cleanup levels. For non-petroleum-related constituents, the cleanup levels were derived in the Cleanup Level Document and proposed as Presidio-wide cleanup levels.

The Cleanup Level Document identifies several steps to select appropriate site-specific cleanup levels (*EKI, 2002; Table 7-6 Revised May, 2006*). This includes identification of the following: impacted media, predominant soil lithologies, planned human land use, planned ecological land use, whether petroleum-related chemicals are present, and resources to be protected. The most stringent (lowest) of these levels were selected as the cleanup level for each chemical of concern (COC) in soil and groundwater throughout the Site, and are (1) media-specific (i.e., identified for both soil and groundwater); (2) location-specific (i.e., identified considering resources and planned land uses at the Building 207/231 Area); (3) chemical-specific (i.e., identified for each COC detected at the Site); and (4) depth-specific (i.e., identified considering the vertical location of the detected COC).

4.2.1 Applicable Soil Cleanup Levels

For soil, the most stringent (lowest or most conservative) cleanup levels were selected based on potential endpoints (e.g., protection of human health, ecological receptors, and water quality) and potential restoration of the Crissy Marsh and Tennessee Hollow Riparian Corridor within the Site discussed in Section 2.3.2.1 as follows:

- Protection of Human Health, Residential Use – Planned land use at the Building 207/231 Area is a mixture of residential and commercial/recreational (*EKI, 2002; Table 7-6 Revised May, 2006*). The more stringent residential cleanup levels were selected as cleanup levels for human health.

- Protection of Ecological Receptors, Buffer Zone/Special-Status – Planned ecological use at the Building 207/231 Area is a mixture of buffer zone and special-status species (*EKI, 2002; Table 7-6 Revised May, 2006*). The more stringent special-status species cleanup levels were selected as cleanup levels for ecological species.

- Protection of Saltwater Ecological Receptors – The saltwater ecological protection zone established under RWQCB Order SCR R2-2003-0080 (Plates 2 and 3a; *RWQCB, 2003*) includes the northern portion of the Site north of the Doyle drive overpass. There is also a possibility that the Crissy Marsh area may be extended just south of Building 231 (Plates 2 and 3a; *BBL, 2004*). Sediment cleanup levels for the Colma formation were selected as cleanup levels for protection of saltwater ecological receptors where point-of-compliance concentrations (POCCs) have not been established.

- Protection of Freshwater Ecological Receptors – The freshwater ecological protection zone established under RWQCB Order SCR R2-2003-0080 (Plates 2 and 3a; *RWQCB, 2003*).

encompasses most of the southern portion of the Site. Reuse plans for the zone include restoration of the Tennessee Hollow drainage corridor through this area. The drainage corridor will include a freshwater stream that will traverse the ecological protection zone and discharge into the tidal wetlands of Crissy Field. Sediment cleanup levels for the Colma formation were selected as cleanup levels for protection of freshwater ecological receptors where point-of-compliance concentrations (POCCs) have not been established.

- Protection of Groundwater at Drinking Water Levels – For petroleum related constituents in soil, a depth to groundwater of less than 5 feet was assumed to evaluate the leaching potential from soil to groundwater at drinking water levels.

- Metals Background Concentrations for Colma Formation – Background threshold metals concentrations for Colma formation were also used to assess metals concentrations (*EKI, 2002; Table 7-6 Revised May, 2006*). The most stringent of the applicable cleanup levels listed above was selected as the cleanup level for each chemical, or in the case of metals, the background concentration for Colma formation was selected as the screening level if it was greater than the other more stringent cleanup level. If the background threshold value was higher than the most stringent cleanup level for a given metal, then the background threshold value was used as the cleanup level for that metal.

- There are several chemicals that have been detected in soil at the Site for which Presidio-specific cleanup levels have not been developed. For these chemicals, environmental screening levels (ESLs) developed by the RWQCB (*2005*), were applied as cleanup levels for this investigation, in accordance with the Cleanup Level Document (*EKI, 2002; Table 7-6 Revised May, 2006*). The ESLs incorporate the following endpoints of concern: human health, ecological protection,

groundwater quality, and surface water quality. Presidio-specific cleanup levels and ESLs were not available for 1,2,4- and 1,3,5-trimethylbenzene, so USEPA Region 9 Preliminary Remediation Goals (*USEPA, 2004*) protective of human health were selected as cleanup levels.

- The chemical 2-hexanone does not have an established cleanup level or an ESL. Based upon physical properties and the limited toxicity data, 2-hexanone appears to be similar to MIBK with respect to both physical properties and toxicity. Therefore, the ESL for MIBK was used as a surrogate cleanup level for 2-hexanone.

Table 3 presents the selected cleanup levels for soil at the Building 207/231 Area.

4.2.2 Applicable Groundwater Cleanup Levels

For groundwater, the most stringent (lowest or most conservative) cleanup levels were selected based on potential endpoints (e.g., protection of human health, ecological receptors, and water quality) and potential restoration of the Crissy Marsh and Tennessee Hollow Riparian Corridor within the Site discussed in Section 2.3.2.1 as follows:

- Protection of Human Health, Drinking Water Levels – The Building 207/231 Area is located within the Northeastern Groundwater Area and Crissy Field Groundwater Area of the Marina Groundwater Basin. The groundwater is a possible source for municipal water supply and surface water replenishment, although the groundwater is not currently used as a drinking water source and it is unlikely that groundwater within the Crissy Field Area could be used for potable purposes because pumping groundwater would likely cause seawater intrusion and land subsidence (*RWQCB, 2003*).

- Protection of Freshwater Ecological Receptors – As discussed above, the freshwater ecological protection zone established under RWQCB Order SCR R2-2003-0080 (Plates 2 and 3a; *RWQCB, 2003*) encompasses most of the southern portion of the Site.

- Protection of Saltwater Ecological Receptors – As discussed above, the saltwater ecological protection zone established under RWQCB Order SCR R2-2003-0080 (Plates 2 and 3a; *RWQCB, 2003*) includes the northern portion of the Site north of the Doyle drive overpass. There is also a possibility that the Crissy Marsh area may be extended just south of Building 231 (Plates 2 and 3a; *BBL, 2004*).

- For chemicals for which Presidio-wide cleanup levels have not been established, RWQCB 2005 ESLs were used as cleanup levels. For human health, Maximum Contaminant Levels (MCLs) for groundwater were selected as cleanup levels where available for COCs; for COCs that did not have an MCL, risk-based values were selected as cleanup levels. For freshwater toxicity, these cleanup levels comprise ESLs for protection of aquatic life or surface water.

Table 4 presents the selected cleanup levels for groundwater at the Building 207/231 Area.

4.3 Chemicals of Concern

Concentrations of detected chemicals were compared to the applicable selected cleanup levels presented in Tables 3 and 4 respectively, for soil and groundwater, in order to identify chemicals that were present at the Site at levels that could potentially pose risk to human health, the environment, or drinking water quality. The following sections describe the chemicals of concern (COCs) identified in soil and groundwater at the Site that exceed cleanup levels.

4.3.1 Chemicals of Concern in Soil

The chemicals that exceed cleanup levels in soil include:

- TPHs – TPH as gasoline, diesel, and fuel oil;
- VOCs – BTEX, MTBE, PCE, TCE, bromobenzene, vinyl chloride;
- PAHs - anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene;
- Metals – arsenic, chromium, cobalt, lead, mercury, nickel, silver, and zinc; and
- Pesticides and PCBs – 4,4’-DDD and Arochlor 1016.

TPH, BTEX, and MTBE are likely present in soil from past fuel and waste oil spills from vehicle maintenance or storage activities, releases from former fuel distribution system (FDS) lines, aboveground storage tanks (ASTs), underground storage tanks (USTs), and also may be contaminants in debris fill material. Accordingly, TPH, BTEX, and MTBE have been retained as COCs.

Because PAHs are a component of petroleum hydrocarbon fuels, and therefore may be present as a result of releases of petroleum hydrocarbons, all PAHs that exceed cleanup levels have been retained as a COC. It should be noted that PAHs such as benzo(a)pyrene could also be derived from other sources such as asphalt fragments that may be present in the debris fill at the Site.

The VOCs PCE, TCE, bromobenzene, and vinyl chloride may be associated with minor use as cleaning solvents. Methylene chloride (MeCl) is a common laboratory contaminant and its occasional detection is considered suspect and unreliable.

Metals can be derived from petroleum hydrocarbons as trace constituents in fuels or in waste oil, from past vehicle maintenance activities, or from past blacksmith activities at the Site. Metals may also be from non-native fill and anthropogenic debris. Lead is the primary metal that exceeded cleanup levels. Lead was detected from 0 to 12 feet bgs with exceedances ranging from 0 to 7 feet bgs. Lead concentrations that were detected below 7 feet bgs typically ranged near the background threshold levels

established by EKI in the Cleanup Level Document (*EKI, 2002; Table 7-6 Revised May, 2006*). The locations and depth at which lead was near background threshold levels appears to be located in native materials (Plates 11a and 11b~~A through 11B~~). Soil borings 230SB101 and 38SB102 both had detections of lead above cleanup levels in the soil samples collected at 3 feet bgs, which were located in fill material and fill material in both locations extends to approximately 3.5 feet bgs. Soil samples collected at 5.5 feet bgs and deeper were below the background threshold concentration of 7.5 mg/kg, with the exception of 230SB101 at 10 feet bgs, which was detected at 12 mg/kg. It appears concentrations of lead greater than 12 mg/kg are associated with fill material or former site operations.

The depth, concentrations, and locations of the COCs in soil are shown on Plates 17a and 17b, respectively, for the Building 207 and Building 231 Areas. Section 4.4 further discusses the COCs in soil.

4.3.2 Chemicals of Concern in Groundwater

The chemicals that exceed cleanup levels in groundwater include:

- TPHs – TPH as gasoline, diesel, and fuel oil;
- VOCs – BTEX, MTBE, bromobenzene, 1,2-DCA, 1,2-DCB, PCE, TCE, and vinyl chloride;
- PAHs - benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, and chrysene, and indeno(1,2,3-cd)pyrene;
- Metals – arsenic, lead, nickel, vanadium, and zinc; and
- PCBs – Arochlor 1016.

TPH, BTEX, and MTBE were retained as COCs because they were detected above cleanup levels and appear to be present in groundwater from past releases from the fuel and waste oil USTs formerly located at the Site.

As discussed above, PAHs and metals are associated with the use of fuels and oils. The non-fuel VOCs are probably associated with the use of cleaning solvents used in maintenance of the vehicles and equipment. All PAHs, metals, and VOCs that exceed cleanup levels have been retained as COCs. The Arochlor 1016 is probably associated with the waste oil UST.

As described above, arsenic was~~and other metals were~~ detected in groundwater above cleanup levels at isolated locations. Arsenic is not believed to be present from a release of metals from past use of the Site for storage and distribution of petroleum fuels or for maintenance of vehicles. In 2006, the Trust conducted a study to further evaluate the presence of arsenic in groundwater and its relationship to petroleum hydrocarbons, soil types, and groundwater chemistry at the Building 207/231 Area, and two neighboring CAP sites—the Building 1065 Area and the Commissary/PX Area. The results of this study were presented in the *Technical Memorandum, Evaluation of Arsenic and Other Metals in Groundwater at Three Corrective Action Plan Sites, Presidio of San Francisco* (Arsenic in Groundwater Tech Memo; *MACTEC, 2006*), and considered in the development of corrective actions for groundwater contamination at the Site. Based on results of the study, arsenic is believed to be present in groundwater at elevated concentrations at these sites primarily due to degradation of petroleum hydrocarbons in saturated soils at or downgradient of a petroleum hydrocarbon release (e.g., from former petroleum storage and distribution facilities at the Building 207/231 Area). It appears that arsenic is being mobilized from its adsorbed state on the iron coatings of soil particles due to more strongly reducing conditions imposed by the biodegradation of petroleum hydrocarbons present in saturated soils where petroleum releases occurred. To a lesser degree, arsenic may tend to mobilize into shallow groundwater due to locally reducing conditions caused by degradation of organic matter in the underlying Bay Mud. In addition, once the arsenic dissolves into groundwater, arsenic concentrations remain relatively stable over time. When the

petroleum source and reducing conditions abate, arsenic concentrations may tend to slowly decrease due to dilution, dispersion, and transport.

~~Review of the arsenic data suggest that it is correlated with reducing conditions that are influenced by a combination of the organic material in the underlying Bay Mud and/or the degradation of petroleum hydrocarbons and a source of arsenic in saturated materials. The presence of organic material in Bay Mud and/or degradation of petroleum hydrocarbons released from USTs may create reducing conditions that reduce the oxidation state of arsenic, which causes arsenic to be soluble in groundwater. After TPH contaminants have been removed, more oxidizing conditions may return, thus oxidizing arsenic and causing it to precipitate from groundwater. Dissolved arsenic is generally not detected above action levels in oxidizing conditions.~~

Therefore, - arsenic in groundwater is retained as a COC and will be analyzed in conjunction with associated redox parameters (indicators of reducing conditions) under the proposed corrective action alternative monitoring program for purposes of further evaluation consistent with the Arsenic in Groundwater Tech Memo (*MACTEC, 2006*) and adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2005; T&R, 2004*).

The locations and concentrations of the COCs in groundwater above cleanup levels are shown on Plates 18a and 18b, respectively for the Building 207 and 231 Areas. Section 4.4.2 further discusses the COCs in groundwater.

4.4 Identification of Remedial Units

This section describes the areas where COCs were detected at concentrations that exceed cleanup levels in soil and groundwater. Based on the occurrence of COCs exceeding cleanup levels, five remedial units were identified, comprising seven areas of soil contamination and four areas of groundwater

contamination as shown on Plates 19a~~A~~ and 19a~~B~~, respectively for the Building 207 and 231 Areas. The remedial units at the Site are described as follows~~:~~

- Former Building 207 Area (Including Former Building 208 Sump) — Two areas of soil contamination co-located with an area of groundwater contamination (Plate 19a~~A~~).
- Former Building 38, 38-A, Garage Area — One area of soil contamination co-located with an area of groundwater contamination (Plate 19a~~A~~).
- Existing Building 231 Area — One area of soil contamination co-located with an area of groundwater contamination (Plate 19b~~B~~).
- Existing Building 228 Area — Two areas of soil contamination co-located with an area of groundwater contamination (Plate 19b~~B~~).
- Existing Building 230 Area —One area of soil contamination (Plate 19b~~B~~).

Former Building 271 Area — One area of soil contamination to be addressed with Building 231 remedial unit (Plate 19b). At one~~isolated~~ location~~s~~, soil and groundwater at the former Building 271 ~~also~~ contained chemicals detected at concentrations slightly above cleanup levels (Plates 17a and 18a). ~~However, this area was not identified as an RU because t~~The chemicals detected were not reported significantly above the cleanup levels, and their mobility, distribution, and frequency of detection are limited and not concentrated within a given area. ~~The chemicals detected at the former Building 271 Area that exceeded cleanup levels in soil included the PAH benzo(a)pyrene, and the metals lead, and zinc; and in groundwater included the PAHs benzo(a)anthracene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, and chrysene.~~ These chemicals have a lower mobility relative to the main petroleum-related COCs present at the Building 207/231 CAP Area (e.g., TPH and VOCs). As discussed previously, metals and PAHs may be derived from past site usage or from non-native fill and anthropogenic debris, and the concentration of lead detected is consistent with

other such isolated exceedances at the Site. In addition to the low concentrations, isolated occurrences, and low mobility, these exceedances occur in locations near the Doyle Drive/Highway 101 overpass where soil may be removed during the planned future reconstruction activities of the overpass. For these reasons, a separate soil remedial unit was not developed or carried through the evaluation of corrective action alternatives for this area. Corrective actions for the Former Building 271 Area have been evaluated with the northwestern portion of the adjacent Building 231 Area that also extends under the overpass (Plate 19b).

For each of the soil and groundwater RUs identified above, potential cleanup technologies will be screened and used to develop corrective action alternatives that will be evaluated and compared in order to select a recommended cleanup alternative for each RU in Sections 5.0 and 6.0 of this CAP. These five RU Areas are further described below.

Former Building 207 Area (Including Former Building 208 Sump) — Two areas of soil contamination in this area are co-located with an area of groundwater contamination associated with the former Building 207 USTs (Plate 19a~~A~~) as follows:

Soil

An area~~Three subareas~~ of soil with chemicals above cleanup levels are present along the edges of the previous 1996 and 1998 excavations, and an additional adjacent area associated with the former Building 208 sump as shown on Plates 17a and 19a. In addition, the 1996 excavation was backfilled with LTTD soil that contains COCs above cleanup levels consistent with the saltwater and freshwater protection zones evaluated for the Site; in addition, LTTD-treated soils is not allowed to be placed within 50-feet of streams (*RWQCB, 1996*). The combined soil subareas, the area of LTTD backfill, and the former Building 208 sump area comprise the approximately 1,130 cubic yards of soil within this RU. The majority of soil containing COCs above cleanup levels is located in the vadose zone from 3 to 3.5 feet bgs

associated with the Building 207 Area, and comprises approximately 1,100 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels in this location include:

- TPHs – TPH as gasoline, diesel, and fuel oil;
- BTEX and MTBE; and
- Metals – lead.

Soil containing COCs above cleanup levels associated with the former Building 208 sump is located in saturated soil from 5 to 7.5 feet bgs, and comprises approximately 30 cubic yards of soil. The COCs that were detected above cleanup levels in this location include:

- TPHs – TPHg, TPHd, TPHfo, and Unknown TPH;
- PAHs – benzo(a)pyrene; and
- Metals – lead and zinc.

The COCs that were detected in groundwater at concentrations above cleanup levels at this area occur in the shallow aquifer at depths ranging from 7 to 16 bgs, and include:

- TPHs – TPH as gasoline;
- Benzene and MTBE;
- PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene; and

Former Building 38, 38-A, Garage Area — The soil RU at this area is co-located with a groundwater RU associated with use of the former Building 38, 38-A and garage areas (Plate 19a~~A~~). The soil RU is located beneath and around the former garage in unsaturated and saturated zone soils between 0.5 and 10

feet bgs, and comprises approximately 670 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels include:

- TPHs – TPH as diesel and fuel oil;
- PAHs – anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene; and
- Metals – arsenic, lead, and zinc.

The co-located shallow groundwater RU occurs at depths ranging from 10.5 to 12 feet bgs, and encompasses the former Building 38 garage, 38-A, and the southeast portion of former Building 38. The COCs that were detected in groundwater at concentrations above cleanup levels include:

- VOCs – toluene and vinyl chloride;
- PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene; and
- Metals – arsenic and nickel.

Existing Building 231 Area — The soil RU at this area is co-located with a groundwater RU associated with the former Building 231 USTs (Plate 20b~~19B~~). The soil RU is located from north of the historic wall to below the Southern Doyle Drive/Highway 101 Overpass, east of Halleck Street, and west of Building 230, encompassing Building 231, ~~and~~ the former locations of the USTs associated with Building 231, and an adjacent area to the west at the Former Building 271 Area (Plates 20b~~19~~ and 19b~~B~~). Due to technical constraints associated with siting and operating investigation equipment near existing roadway structures below the Southern Doyle Drive/Highway 101 Overpass, the extent of contamination in the northern portion of this area and south of former Building 207 are unknown, and will be assessed in

coordination with the Doyle Drive reconstruction efforts.~~The extent of chemicals in soil extending north of the Southern Doyle Drive/Highway 101 Overpass and south of former Building 207 has not been fully characterized, so the northern extent of the area is not known.~~ The soil RU is located in unsaturated and saturated zone soils between 0.5 to 10 feet bgs, and comprises approximately 7,200~~190~~ cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels include:

- TPHs – TPH in the ranges of gasoline, diesel, and fuel oil;
- VOCs – BTEX, methylene chloride (MeCl), PCE, and vinyl chloride;
- PAHs – benzo(a)pyrene, benzo(b)fluoranthene, and benzo(b+k)fluoranthene;
- Metals – arsenic, chromium, cobalt, lead, mercury, nickel, silver, and zinc; and
- Pesticides and PCBs – 4,4’-DDD and Arochlor 1016.

A co-located shallow groundwater RU occurs at depths ranging from 8 to 24 feet bgs is located from north of the historic wall to below the Southern Doyle Drive/Highway 101 Overpass, east of Halleck Street, and east of Building 231 and the former Building 231 (Plate 19b~~B~~). Current groundwater conditions below the Southern Doyle Drive/Highway 101 Overpass are not known due to technical constraints associated with siting and operating equipment around existing roadway structures, so the northern extent of this area is not known, and will be assessed in coordination with the Doyle Drive reconstruction efforts. The COCs that were detected in groundwater at concentrations above cleanup levels include:

- TPHs – TPH in the ranges of gasoline, diesel, and fuel oil;
- VOCs – BTEX, bromobenzene, 1,2-DCA, PCE, and TCE;

- PAHs – benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, benzo(k)fluoranthene, and chrysene;
- Metals – lead, nickel, vanadium, and zinc; and
- PCBs – Arochlor 1016.

Existing Building 228 Area — The soil RU at this area is co-located with a groundwater RU associated with the former Building 228 USTs (Plate 19b~~B~~). The areas of soil containing COCs above cleanup levels are located between historic Building 228 and the historic wall within the excavation associated with the former 228 USTs (Plate 19b~~B~~), and just south of Building 228 within an area that formerly contained a fuel distribution system (FDS) line. The northern soil RU is located in unsaturated and saturated soil between 1 to 11 feet bgs, and comprises approximately 120 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels in the Northern Soil RU include:

- TPH as gasoline, diesel, and fuel oil;
- Ethylbenzene, and xylenes.

The COCs that were detected in groundwater at concentrations above cleanup levels in the Northern Soil RU include:

- TPH as gasoline, diesel, and fuel oil;
- Ethylbenzene, and xylenes;
- 1,2-dichlorobenzene (1,2-DCB), and
- Nickel.

The southern soil RU is located immediately south of Building 228 within the former excavation associated with the FDS lines, and is located immediately adjacent to and beneath the south side of the

historic Building 228. Soil contamination is located in vadose zone soil at 6 feet bgs, and comprises approximately 30 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels in the Southern Soil RU include:

- TPH in the diesel and fuel oil ranges.

The co-located shallow groundwater RU occurs at a depth of 16 ft bgs, and extends from north of Building 228 to south of the historic wall, within the excavation associated with the former 228 USTs (Plate 19b~~B~~). The COCs that were detected in groundwater at concentrations above cleanup levels include:

- TPHs – TPH as gasoline, diesel, and fuel oil;
- VOCs – 1,2-DCB; and
- Metals – nickel.

Existing Building 230 Loading Dock — The soil RU at this area is associated with railroad activities conducted east of existing Building 230, which includes a portion of the railroad spur (Plate 19b~~B~~). COCs above cleanup levels occur in vadose zone soils between 3 to 5.5 feet bgs adjacent to and just east of the building, and comprise approximately 400 cubic yards of soil. The COCs that were detected in soil at concentrations above cleanup levels include:

- TPHs – TPH in the diesel and fuel oil ranges;
- PAHs – acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b+k)fluoranthene, and pyrene; and
- Metals – lead.

Groundwater was not sampled in this area; however, soils were sampled until saturated soils were encountered at 10 feet bgs, and no COCs were detected above cleanup levels. Therefore, this is the only soil RU at the Site that is not co-located with a groundwater RU. However, because groundwater has not been sampled within this RU to verify there have been no impacts from COCs in soil, the corrective action alternatives for the Building 230 RU will include groundwater sampling and monitoring as under the other RUs with known contamination.

5.0 SUMMARY AND EVALUATION OF ALTERNATIVES

This section presents the summary and evaluation of corrective action alternatives for the soil and groundwater RUs described in Section 4.4 and shown on Plates 19a~~A~~ and 19b~~B~~ within the Building 207/231 CAP Area. Trench locations and soil sampling data from the subsurface geoarchaeological survey conducted at the Site in January 2006 to assess potential cultural and/or historic resources in this area prior to implementation of the selected corrective action alternatives are also shown on Plates 19a and 19b (*ASC & MACTEC, 2006*).

This section is organized as follows:

- Section 5.1: Identification and Screening of Potential Remedial Technologies — Describes the site-specific considerations, and identifies and screens potential remedial technologies for each of the soil and groundwater remedial units based on the three initial evaluation criteria of effectiveness, implementability, and relative cost.
- Section 5.2: Corrective Action Alternatives Considered — Describes the corrective action alternatives considered for each remedial unit that are assembled from the range of remedial technologies retained in the initial screening.
- Section 5.3: Criteria for the Evaluation of Corrective Action Alternatives — Describes the criteria used to evaluate each alternative in terms of its ability to meet the evaluation criteria of effectiveness, implementability, and cost, and achieve the Remedial Action Objectives (RAOs) described in Section 4.1.
- Section 5.4: Evaluation of Corrective Action Alternatives — Evaluates and compares the corrective action alternatives considered for each remedial unit based on how well they meet the evaluation criteria and achieve RAOs as summarized in Table 5.

- Section 5.5: Recommended Corrective Action Alternatives — Presents the rationale for selection of a recommended corrective action alternative for each remedial unit based on the evaluation and comparison of alternatives as summarized in Table 6.

5.1 Identification and Screening of Potential Remedial Technologies

This section identifies site-specific considerations and screens the potential soil and groundwater remedial technologies that could be applied as part of corrective actions to address the contaminants in the remedial units (RUs) identified in Section 4.4, and shown on Plates 19a~~A~~ and 19b~~B~~.

5.1.1 Site-Specific Considerations

The following site-specific considerations (resources, potential future uses, and programmatic data issues) for the Building 207/231 CAP Site were considered in the screening of potential technologies and development of corrective action alternatives as follows:

- Cultural Resources: Potential impacts to cultural resources that may be present within these RUs during implementation of corrective action alternatives would be minimized by requiring archaeological monitoring during intrusive activities to prevent adverse impacts. - The results of the subsurface geoarchaeological survey conducted at the Site in January 2006 did not identify significant artifacts of archaeological research value (*ASC & MACTEC, 2006*).

- Historic Resources: Potential impacts on historic resources that may be present within these RUs (i.e., Building 228 and the adjacent historic wall) would be mitigated by developing and recommending corrective action alternatives for these RUs that would not adversely affect their integrity (e.g., capping instead of excavation).

- Potential Crissy Marsh and Tennessee Hollow Riparian Corridor Expansions: Cleanup levels protective of these potential future uses as well as current uses were developed and used to define

remedial units and corrective action alternatives. In addition, a range of backfilling options that would accommodate current and potential future uses were developed and costed for each RU as appropriate, and include: (A) Backfill Option A—Open excavation with semi-permanent drainage system to prevent overflow with stabilization/restoration of the excavation area and replacement of existing roadways as necessary; (B) Backfill Option B—Partial backfill of excavation to above water table and stabilization with materials (such as sand and dune grasses) compatible with future restoration and replacement of existing roadways as necessary; install semi-permanent drainage system; (C) Backfill Option C—Complete backfill of excavation and restoration of site to match existing grade and conditions and replacement of existing roadways as necessary.

- Replacement of the Doyle Drive/Highway 101 Overpass: Corrective actions to remediate contamination and replace roadways and associated structures under existing site conditions were considered, as well as for the potential Doyle Drive replacement alternatives.

- Arsenic in Groundwater: As described in the Arsenic in Groundwater Tech Memo (*MACTEC, 2006*), elevated dissolved arsenic concentrations in shallow groundwater are likely the result of geochemical changes caused by locally reducing conditions from degradation of organic matter in the underlying Bay Mud and degradation of petroleum hydrocarbons. Therefore, although no formal arsenic groundwater remedial unit has been established for the Site, groundwater monitoring for arsenic and associated parameters is included in the corrective actions for the Site.~~Review of the arsenic data in groundwater at this and other adjacent sites suggest that it is correlated with reducing conditions that are influenced by a combination of the organic material in the underlying Bay Mud and/or the degradation of petroleum hydrocarbons and a source of arsenic in saturated materials. Therefore, arsenic is retained as a COC, and in conjunction with redox parameters (indicators of reducing conditions) will be included in the proposed corrective~~

~~action alternative monitoring program for purposes of further evaluation consistent with the adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2004b; T&R, 2005*).~~

5.1.2 Identification and Screening of Potential Remedial Technologies

The three initial evaluation criteria of effectiveness, implementability, and relative cost are used to screen potential remedial technologies identified for the five RUs identified for the Building 207/231 CAP Area as follows:

Effectiveness

Effectiveness refers to the ability of a technology to address: 1) the estimated area or volumes of media requiring remediation to meet the RAOs; 2) the potential impacts to human health and the environment during implementation; and 3) the long-term reliability and proven history of the technology with respect to remediating the types of chemicals and site conditions within each remedial unit.

Implementability

Implementability refers to both the technical and administrative feasibility of implementing a particular remedial technology, including: 1) the likelihood of obtaining permits and approvals from regulatory agencies; 2) the availability of appropriate treatment, storage, and disposal facilities; and 3) the availability of the equipment, materials, skilled workers, and other resources.

Relative Cost

Relative cost includes the anticipated order-of-magnitude capital, and operation and maintenance (O&M) costs associated with implementing a particular remedial technology. This criterion evaluates whether the capital and operating costs of implementing the technology are low, moderate, or high as compared to other applicable technologies. Relative costs are estimated based on experience on similar projects; engineering judgment; and remediation technology databases. Required expenditures are compared

against the potential benefits of each technology, and can be used to eliminate options that are substantially more expensive than other technologies that provide the same level of protection.

The potential remedial technologies that are considered in the screening include:

- No action;
- Land use controls;
- Capping;
- Excavation of soil with ex situ soil treatment;
- Excavation of soil with offsite disposal;
- In situ soil and groundwater treatment; and
- Extraction and ex situ groundwater treatment.

The remedial technology screening focuses on petroleum-related COCs present within the RUs (e.g., TPH and VOCs) that are the primary COCs in terms of their distribution and frequency of detection, and does not specifically consider treatment of inorganic contaminants (e.g., the metals arsenic, lead, zinc) for the following reasons:

- Metals in Soil: As described in Section 4.3.1, there are isolated occurrences of metals in soil above cleanup levels in each of the RUs. With the exception of arsenic (Section 4.3.2) whose presence in groundwater is primarily due to mechanisms related to the presence of reducing conditions rather than a release of site-related arsenic contamination in soils based on the results of the Arsenic in Groundwater Tech Memo (*MACTEC, 2006*), metals in soil do not appear to have impacted groundwater, and their distribution and frequency of detection is limited. There are no readily available, proven, and implementable remedial technologies for treating isolated occurrences of metals in soil. In addition, metals in soil are unlike organic compounds that can vaporize and migrate to the surface and present potential exposures, and the majority of the

surface area of these RUs are covered by existing pavement or buildings which effectively eliminate the exposure pathways to subsurface metals. Therefore, remedial technologies specific to metals in soil are not evaluated further, and it is assumed the corrective action alternatives that may be implemented to address petroleum-related COCs in soil would address isolated occurrences of metals in soil as well (e.g., capping, excavation).

- Metals in Groundwater: As described in Sections 4.3.2, arsenic and other metals were detected in groundwater above cleanup levels at isolated locations. As described in the Arsenic in Groundwater Tech Memo (*MACTEC, 2006*), elevated dissolved arsenic concentrations in shallow groundwater are likely the result of geochemical changes caused by locally reducing conditions from degradation of organic matter in the underlying Bay Mud and degradation of petroleum hydrocarbons. Therefore, although no formal arsenic groundwater remedial unit has been established for the Site, arsenic will be retained as a COC for groundwater and concentration trends will be monitored under each of the corrective action alternatives that may be implemented to address petroleum-related COCs in soil and groundwater for purposes of further evaluation consistent with the adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2004b; T&R, 2004*). Other metals detected in groundwater above cleanup levels will also be monitored under the corrective actions for the Site. ~~Review of the arsenic data suggest that it is correlated with reducing conditions that are influenced by a combination of the organic material in the underlying Bay Mud and/or the degradation of petroleum hydrocarbons and a source of arsenic in saturated materials. Therefore, arsenic will be retained as a COC for groundwater and concentration trends will be monitored under each of the corrective action alternatives that may be implemented to address petroleum-related COCs in soil and groundwater for purposes of further evaluation consistent with the adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2004b; T&R, 2004*).~~ Remedial technologies specific to arsenic or other metals in groundwater are not evaluated further at this time.

The potential remedial technologies for soil and groundwater contaminated with petroleum-related COCs are described and screened below based on their effectiveness, implementability, and relative cost. These discussions indicate whether each technology is either retained for further consideration, or eliminated from further consideration as components of the potential corrective action alternatives described in Section 5.2.

5.1.2.1 No Action

The "no action" technology assumes no corrective actions of any kind would be implemented to address the presence of contaminants in soil or groundwater. No action is not anticipated to be effective or administratively implementable for soil and groundwater RUs within the Building 207/231 CAP Area that contain COCs above cleanup levels; however, it is included in the evaluation as a baseline for comparison to other alternatives. There are no costs associated with implementing no action.

No Action is retained for further consideration for both soil and groundwater RUs as a corrective action alternative.

5.1.2.2 Land Use Controls

Land use controls (LUCs) refer to administrative restrictions on the potential future use of land based on the levels of contaminants that may be left onsite at concentrations greater that allow for unrestricted use. The Trust generally does not consider LUCs by themselves to meet the cleanup goals for sites where contaminated materials remain left in-place and potentially exposed. LUCs restrict future site use and future site activities in order to limit exposure to COCs left in place or to ensure the effectiveness of the selected site remedy. Plate 1 shows the designation of Area A and Area B at the Presidio. ~~either (1) in lieu of other corrective actions; (2) in combination with other corrective actions; or (3) after other corrective actions have been implemented. LUCs would restrict future site disturbance or maintain site cover in order to minimize environmental exposure to any remaining site risks due to potential exposure to COCs.~~ The Building 207/231 CAP Area RUs are located in Area B of the Presidio. Existing and

planned land uses in Area B are directed by the Trust through its comprehensive land use and management plan, the Presidio Trust Management Plan (PTMP) (*Trust, 2002*). LUCs in Area B are managed in accordance with the Presidio Trust's Land Use Control Master Reference Report (LUCMRR). ~~LUCs for Area B remediation sites include restricting or controlling site uses by administrative procedures such as preparing a site-specific addendum to the Presidio Trust's Land Use Control Master Reference Report (LUCMRR).~~

~~Trust planning/project proponents and members of the public may review all existing LUCs for the Presidio by reviewing the LUCMRR in the Trust Library. The Trust would notify DTSC and RWQCB of any proposed action that may disrupt the effectiveness of the LUCs, and any proposed action that could alter or eliminate the continued need for LUCs.~~

~~The Trust generally does not consider LUCs by themselves to meet RAOs for sites where contaminated materials remain left in-place and potentially exposed. LUCs may be used in combination with certain engineering controls (e.g., capping) that create a physical barrier between the contaminated material and human or ecological receptors. LUCs are used to protect the engineering controls by preventing soil disturbance and exposure.~~

The LUCMRR serves as the Trust's overall implementation and enforcement plan to meet the requirements of State of California requirements and §5.11 of the Consent Agreement (DTSC, **Error! Reference source not found.**). The LUCMRR provides the framework to LUC management in Area B and describes the procedures the Trust will use to track, implement and enforce LUCs at remediation sites in Area B where LUCs are part of the selected remedy. For each individual site identified as requiring a LUC, a site-specific addendum to the LUCMRR will be prepared. Each site-specific LUCMRR addendum will include a figure depicting the site location and nearby area, and will summarize the site history, the specific COCs encountered at the site, the actions taken to remediate the site, the in-place management system (such as containment), the levels and general locations of COCs remaining at the site

that required the implementation of the LUC, and site-specific restrictions for that LUC area. In addition, these site-specific addenda will discuss restricted or prohibited land uses at the site and any special requirements (e.g., health and safety requirements) if the area is disturbed in the future. The site-specific LUCMRR addenda will be added to the Trust's GIS system that serves as an informational database for all remediation sites with LUCs in Area B of the Presidio. The LUCMRR identifies the content requirements of site-specific addenda.

As a federal agency, the Trust is required under NEPA to consider the potential environmental impacts of any project, plan, program, or action at the earliest stage of planning and before implementation. The Trust carries out this obligation using a project review process that screens proposals for compliance with NEPA/NHPA ("N^2"), and other such laws and regulations. The Trust's N^2 compliance process screens every proposed action in Area B at the Presidio (e.g., fence post installation, tree trimming, native plant restoration, building renovation, and building demolition). The N^2 compliance process (i.e., project review program) is a first step to insure that Trust staff is aware of known contamination and associated LUCs in the vicinity of project sites. This review process, by scrutinizing the attributes of the project site and the proposed action, can be used to alert Trust staff to known and remediated hazardous substance sites, as well as LUCs.

In addition, for any Area B project involving construction, excavation, or subsurface work, the Trust requires not only N^2 clearance but also a Excavation Clearance Permit. For any project, the permit process requires Preliminary Design, Preliminary Plan Review, Design Development, and Permit Plan Review and approval. Here too, at the earliest stage of project planning, the Trust project manager, tenant, or user is provided with an information checklist with key information about the project site, including any LUCs. The Trust will use its project permit process to notify and require adherence by project proponents to any LUC restrictions and requirements. Both the Trust's project review and project permitting programs will include a link (i.e., in both the standardized N^2 project screening form and the project permit checklist) to the Trust's GIS system containing complete LUC site information.

In general, LUCs in Area B of the Presidio are intended to fulfill the following goals:

- Maintain protection of human health and the environment over time;
- Prevent inappropriate land use of the property containing residual contamination in soil or groundwater;
- Assure that information about the property containing residual contamination in soil or groundwater is available to the local government or the public;
- Ensure that long-term mitigation measures and monitoring requirements are carried out and maintained;
- Ensure that the integrity and stability of the remedy (implemented corrective action alternative) is maintained;
- Ensure that subsequent property owners or transferees have a duty to assume any responsibility for requirements or restrictions pertaining to the residual contamination in soil or groundwater when the property is transferred; and
- Ensure that appropriate regulatory agencies will be contacted prior to a change in land use or change to the selected remedy.

~~LUCs typically include the following restrictions and requirements:~~

- ~~**Allowable Land Uses** – The allowable land uses may be restricted. For example, residential uses may not be allowed.~~
- ~~**Administrative Controls** – For a project that involves excavation or intrusion into the subsurface within the LUC area, a project permit, including excavation clearance and project conditions and mitigations, will be applied for and approved by the Trust prior to commencement of surface disturbance.**Management of Excavated Soils/Materials** – All soils excavated within the LUC~~

~~area must be managed and/or disposed in accordance with then applicable federal, state and local laws governing excavation, handling, management, and disposal of the excavated material.~~

- ~~**Imported Fill** – Imported fill must meet the cleanup levels for the applicable land use.~~
- ~~**Management of Surface Water/Groundwater** – All waters impacted with COCs above cleanup levels within the LUC area must be managed and/or disposed in accordance with then applicable federal, state and local laws governing monitoring, management, and disposal.~~

If LUCs are implemented at the Building 207/231 CAP Area, the Trust will undertake the procedures below ~~will be followed~~ to ensure that the appropriate~~specified~~ LUCs are adhered to by present and future owners and users of the Site:

- **Prepare a Site-Specific Addendum to LUCMRR** – This site-specific addenda to the Trust's LUCMRR will be specific to those portions of the Building 207/231 CAP Area where LUCs are incorporated into the selected remedy. Each site-specific LUCMRR addendum will include a figure depicting the site location and nearby area, and will summarize the site history, the specific COCs encountered at the site, the actions taken to remediate the site, the in-place management system (such as containment), the levels and general locations of COCs remaining at the site that required the implementation of the LUC, and site-specific restrictions for that LUC area. In addition, these site-specific addenda will discuss restricted or prohibited land uses at the site and any special requirements (e.g., health and safety requirements) if the area is disturbed in the future. The Site-Specific Addendum to the LUCMRR for the Building 207/231 Area will be submitted with the Construction Completion Report for this site.

- **Project Permit Process** – In advance of implementation, all Presidio plans and projects in the vicinity of the Building 207/231 Area will be screened by the N^2 process and Excavation Clearance Permit ("dig permit" process). Planning/project proponents will be notified of the LUCs specific to the Building 207/231 Area. The Trust will require adherence to the restrictions

and requirements set forth in the Site-Specific Addendum to the LUCMRR for the Building 207/231 Area. ~~In advance of implementation, all Presidio plans and projects must be screened for compliance with the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA). The Trust, as applicable, will use its interdisciplinary NEPA/NHPA environmental screening process to notify planning/project proponents of the LUC and require adherence to the restrictions and requirements set forth for any plan/project involving the LUC area. In addition, for any project involving excavation or subsurface intrusion within the LUC area, the Trust must approve a "dig permit" to ensure that subsurface utilities (water, gas, sewer, fiber optic) are not damaged. The Trust will also use its Excavation Clearance Permit process to notify and require adherence by excavation project proponents of the LUC restrictions and requirements.~~

- ~~**LUCs Master Reference Report** – The LUC area will be included in the Trust's LUC Master Reference Report (LUCMRR), which includes a master map showing all Presidio-wide LUC Zones and a compilation of all Presidio LUCs requirements and restrictions that is maintained and kept current at the Trust Library. Planning/project proponents and other members of the public may review all existing LUCs for the Presidio by reviewing the LUCMRR at the Trust Library.~~

- **LUC Tracking in the Trust's GIS Database** – The Trust will include LUC area(s) for the Building 207/231 Area in the GIS database that the Trust is preparing to monitor its LUC sites. This database will be available to Trust staff to facilitate decision making and land use planning for Presidio sites.

- **Notification and Annual Monitoring** – The Trust will prepare an annual Presidio LUC Report to confirm that land uses within Presidio are consistent with the restrictions and requirements of all LUC areas in Area B of the Presidio. The Trust will provide DTSC and RWQCB with a copy of this annual report~~The Trust will notify DTSC and RWQCB regarding a proposed land use plan~~

~~or project that may be inconsistent with the LUC, any proposed action that may disrupt the effectiveness of the LUC, and any proposed action that could alter or eliminate the continued need for the LUC. The Trust submits an annual Presidio LUC Report to confirm that human land uses within Presidio LUC Zones are consistent with the restrictions and requirements specified~~. In addition, the Trust will notify DTSC and RWQCB of any proposed action that may disrupt the effectiveness of the LUCs, and any proposed action that could alter or eliminate the continued need for LUCs.

- **Transfer of Ownership or Control** – The Trust will notify DTSC and RWQCB of any anticipated transfer of ownership or control of any portion of a~~the~~ LUC area in Area B of the Presidio. In the event of a transfer of ownership or control of the LUC area, in whole or in part, the Trust will record the Presidio's LUCMRR with the City and County of San Francisco Recorder's Office and the Federal General Services Agency (GSA) to place subsequent Presidio owners or managers on notice of the existence of the LUC area. As part of the administrative transfer of the Site, the Trust will notify the subsequent owner or manager of the duty to comply with the LUC and provide a current~~complete~~ copy of the LUCMRR.

LUCs are anticipated to be effective and implementable for soil and groundwater RUs within the Building 207/231 CAP Area, specifically for RUs that are less accessible and/or have low-level residual contamination. The relative cost of implementing an LUC is low.

LUCs are retained for further consideration for both soil and groundwater RUs in combination with other remedial technologies.

5.1.2.3 Capping

Capping involves either placing a synthetic surface layer (geotextile or geomembrane) or new soil cover, or enhancing or replacing an existing surface cover (soil, asphalt, or concrete) over a contaminated area as a barrier to (1) isolate and prevent exposure to human and/or ecological receptors to contaminants in the

soil; and (2) minimize surface water infiltration that could potentially promote migration of contaminant sources in soil into groundwater. A cap would require long-term inspection and maintenance to maintain its integrity, and intrusive activities within the capped area would need be administratively restricted by implementing and maintaining a land use control (LUC) for the area.

For all Soil and Groundwater RUs for which capping is implemented, groundwater monitoring would be conducted at one or more downgradient well or piezometer location depending on RU-specific conditions in order to monitor concentration trends of COCs and assess the effectiveness of the remedy. The proposed Groundwater Monitoring Program is summarized in Table 7, and monitoring locations are shown on Plate 21.

Capping is anticipated to be effective and implementable for soil and groundwater RUs within the Building 207/231 CAP Area, specifically for RUs that are less accessible and/or have low-level residual contamination. The relative cost of this technology is low, especially where an existing barrier (e.g., a paved surface) can simply be improved upon (e.g., resealed, patched) if necessary.

Capping is retained for further consideration for both soil and groundwater RUs in combination with other remedial technologies.

5.1.2.4 In Situ Soil and Groundwater Treatment

Treatment technologies involve the reduction of the toxicity, mobility, or volume of COCs present in soil or groundwater. In situ soil and groundwater treatment technologies involve treatment in place in the subsurface without excavation or groundwater extraction, and for the COCs present within the Building 207/231 CAP Area RUs potentially include:

- Bioremediation technologies: biosparging, bioventing, and enhanced bioremediation with an oxygen release product;

- Sparging and extraction technologies: air sparging, ozone sparging, and soil vapor extraction; and
- Chemical oxidation technologies: hydrogen peroxide and sodium persulfate.

These treatment technologies could be implemented as stand-alone technologies for soil contamination only (single-phase), or could be implemented to treat both soil and groundwater (dual-phase) in areas where these RUs overlap or are co-~~l~~located.

Application of an oxygen release product (e.g., Oxygen Release Compound [ORC®] or equivalent technology) is the only in situ treatment option retained for further consideration for co-~~l~~located soil and groundwater contamination based on (1) an evaluation of the site-specific effectiveness of the various in situ treatment technologies for the COCs present in the soil and groundwater RUs within the Building 207/231 CAP Area, (2) results of the Phase II Interim Action Work Plan for Building 1063 under the Building 1065 Area CAP that selected oxygen release product as the most effective and preferred technology for the types of COCs present in these RUs (*MACTEC, 2004a*), and (3) consideration of the implementability and relative cost of the various options. For TPHg and VOCs in soil and groundwater RUs, other bioremediation and sparging and extraction technologies would not be as effective as oxygen release products, and chemical oxidation can impact saturated zone geochemistry and increase the solubility of metals in the subsurface.

For Soil RUs with heavier-end TPH compounds such as TPH in the diesel and fuel oil range (which are the primary COCs within these RUs) that mainly occur in unsaturated soils, typically they can not be effectively treated using the above technologies that rely on oxygen release products or volatilization (sparging, venting, vapor extraction).

The oxygen release product technology could be applied via two different methods: (1) application and mixing~~of~~ within saturated soils in the excavation bottom~~floor~~ as part of the excavation technology described below, and (2) in situ injection beneath the surface using injection wells, as follows:

Application Within Excavation: For RUs that will be excavated, oxygen release product could be applied and mixed with soils within the top several feet of the floor of the excavation to provide long-term treatment of any residual COCs in soil and groundwater. However, as described in Section 5.1.2.7 below, excavation into Bay Mud and significant dewatering has been demonstrated as effective for removal of petroleum-related sources and reduction of COCs in groundwater below cleanup levels. In addition, placement of an oxygen release product within the excavation results in lowering the permeability of saturated soils, which would not be desirable if the Site is restored as marsh or riparian corridor. Therefore, application of an oxygen release product within excavations is not anticipated to be necessary and is eliminated from further consideration at this time, but would be considered as a contingency in the field based on (1) potential technical limitations of removing visible/field-measurable organic COC contamination using standard excavation and dewatering techniques, and (2) RU-specific reuse considerations (i.e., it would not be considered for Backfill Options A and B within RUs where the Crissy Marsh or THRC expansion may occur and ecological receptors could potentially come in contact with the oxygen release product).

Application Via Injection: For RUs that will not be excavated, oxygen release product would be applied via injection wells or using direct push technology (DPT) to provide long-term in situ treatment of COCs in soil and groundwater over a period of several months to several years. This technology would only be considered in combination with capping of the Building 228 RU, which is a smaller-sized, inaccessible RU where a co-located Groundwater RU occurs directly upgradient of the Building 231 RU that could potentially be re-contaminated if COCs are not treated.

Based on this technology's limited effectiveness in addressing the range of contaminants present within the large Building 207/231 CAP Area RUs, in situ treatment is not retained for development as a corrective action alternative. However, in situ injection of oxygen release product within inaccessible areas directly upgradient of other RUs (i.e., Building 228 RU) is retained as a component of the capping alternative for this RU.

In situ treatment using an oxygen release product is eliminated from further consideration as a stand-alone corrective action alternative. This technology is retained for application via in situ injection in combination with capping where the RU is directly upgradient of other RUs (i.e., Building 228 RU only).

5.1.2.5 Extraction and Ex Situ Groundwater Treatment

This technology would be difficult to implement within the shallow aquifer within these groundwater RUs because it would have significant impacts on the ongoing and planned operations and restoration activities within the Building 207/231 Area due to installation and operation of equipment that would remain in place and require monitoring and maintenance as well as reuse/reinjection of treated groundwater within this area. In addition, its effectiveness in extracting and treating low concentrations of COCs in groundwater for the subsurface conditions in this area (i.e., a shallow, low-flow groundwater table) may be limited, with a relatively high associated cost.

Extraction and ex situ groundwater treatment is eliminated from further consideration.

5.1.2.6 Excavation and Ex Situ Soil Treatment

Ex situ soil treatment technologies treat contaminated soils after they are excavated from the subsurface, and include low-temperature landfarming, ex situ soil vapor extraction (SVE), biopiles, or low-temperature thermal desorption (LTTD). Ex situ technologies have certain advantages over in situ methods, such as easier verification sampling, greater process control, and lower unit cost, and they can be implemented onsite or offsite depending on site-specific considerations. However, under current

disposal market conditions in California, treating nonhazardous soils prior to offsite disposal to meet the acceptance criteria of a less expensive disposal facility, whether performed onsite or offsite, is not cost effective. Construction and operation of a high-profile ex situ soil treatment unit onsite in public areas to address limited volumes of soil is not practical or cost effective. Onsite stockpiling and treatment of petroleum-contaminated soil would also create nuisance issues such as visual impacts and odors. There are a limited number of offsite facilities that will treat petroleum-contaminated soil prior to disposal, and transportation to such facilities and treatment costs are high.

Excavation and ex situ onsite or offsite soil treatment is eliminated from further consideration.

5.1.2.7 Excavation and Offsite Disposal

Excavation is a practical source removal technology that would be applicable for the conditions at the Building 207/231 CAP Area. This technology has been demonstrated as effective for remediation of COCs below cleanup levels in both soil and co-located groundwater RUs at the adjacent Building 1065 CAP Area when dewatering and removal of all contaminated soils above (or extending into) Bay Mud is implemented (*MACTEC, 2004b*). The majority of contamination at this Site is located within the upper 10 feet of the subsurface, which can be removed using conventional excavation techniques (e.g., excavators, backhoes). These techniques are capable of removing soil contamination to depths of approximately 15 feet bgs without shoring, which is deeper than the maximum anticipated depth of contamination at each soil RU, including any capillary fringe or ‘smear zone’ contamination. The smear zone is defined as a vertical horizon of petroleum-related contamination that may occur at the saturated zone/water table interface. In this zone, petroleum-related COCs present in soil can be ‘smeared’ up and down several feet of the soil column due seasonal or other fluctuations in groundwater elevations. This smear zone may extend several feet into the groundwater table, and extend into the Bay Mud, which acts as a barrier to further vertical migration of contaminants due to its significantly lower permeability. This Bay Mud extends beneath the majority of the Site, and varies from approximately 8 to 15 feet bgs throughout the Building 207/231 CAP Area as shown on Plates 6 through 10. Based on site data, the Bay

Mud is approximately coincident with the water table and serves as an aquitard and barrier to the vertical migration of contaminants. Therefore, contamination appears to be confined at this and other adjacent sites (such as the Building 1065 CAP Area) to the silty sand and clayey sand that overlies the Bay Mud (*MACTEC, 2004b*).

Smear zone contamination is likely present within the Building 207/231 Site RUs, and may continue as a source of contamination to groundwater if not completely removed. Therefore, the excavations will be designed to extend below the smear zone into the Bay Mud aquitard to the extent that is technically practicable and/or necessary to remove petroleum-related contamination. This approach, when combined with significant dewatering of the excavations with the intent of removing the entire pore volume of impacted groundwater within the co-located groundwater RUs, is anticipated to be effective and implementable for remediation of both soil and groundwater containing COCs above cleanup levels.

<u>Backfilling Options</u>

In order to provide flexibility in planning for the potential Crissy Marsh expansion that may occur within the Building 207/231 CAP Area, the following three backfill options are considered for each RU:

- <u>*Backfill Option A*</u>: Open excavation with semi-permanent drainage system to prevent overflow with stabilization/restoration of the excavation area and replacement of existing roadways as necessary;

- <u>*Backfill Option B*</u>: Partial backfill of excavation to above water table and stabilization with materials (such as sand and dune grasses) compatible with future restoration and replacement of existing roadways as necessary and semi-permanent drainage system installed;

- <u>*Backfill Option C*</u>: Complete backfill of excavation and restoration of site to match existing grade and conditions and replacement of existing roadways as necessary.

Excavation and removal of all petroleum-affected soils to below the smear zone; removal of groundwater within the excavation that may be impacted by smear zone contamination via dewatering; soil confirmation sampling; backfilling via Options A, B, or C described above; and groundwater monitoring to verify COCs are below cleanup levels and the source of contaminants to the groundwater RUs has been eliminated would be consistent with the proposed future land uses of the following RUs:

- <u>Former Building 207 Area (Including Building 208 Sump) Soil and Groundwater RU:</u> Excavation and removal is anticipated to extend into the Bay Mud, and would extend laterally to encompass the entire Soil RU. There are no lateral access limitations (e.g., buildings, roadways, utilities, historic structures) on the ability to implement excavation for this RU. This RU is within the planned Crissy Marsh expansion area; therefore Backfill Options A, B, and C will be considered and costed for this RU.

- <u>Former Building 38, 38-A, Garage Area Soil and Groundwater RU:</u> Excavation and removal is anticipated to extend into the Bay Mud, and would extend laterally to encompass the entire Soil RU. There are no lateral access limitations (e.g., buildings, roadways, utilities, historic structures) on the ability to implement excavation for this RU. This RU is within the planned Crissy Marsh expansion area; therefore Backfill Options A, B, and C will be considered and costed for this RU.

- <u>Existing Building 231 Area Soil and Groundwater RU:</u> A portion of the soil RU extends beneath the foundation of existing Building 231 and abuts an historic wall, both that are designated to be preserved. Therefore, excavation of soil from this RU would be conducted after Building 231is demolished to provide access to soils beneath the building foundation and the area between the foundation and wall. This RU is within the planned Crissy Marsh expansion area; therefore Backfill Options A, B, and C will be considered and costed for this RU.

- Existing Building 228 Area Soil and Groundwater RU: A portion of the soil RU abuts historic Building 228 and extends beneath an historic wall, both that are designated to be preserved. Therefore, excavation of soil from this RU could not be conducted without impacts to the structural integrity of the building and historic wall, and is not considered further.

- Existing Building 230 Area Soil RU: The soil RU is adjacent to Building 230 that is designated for continued use. Therefore, excavation of soil from this RU would be conducted using methods that would mitigate impacts to the building's structural integrity. ~~.~~The approximate limitations on extent of over-excavation in this RU would be based on confirmation sampling as follows: (a) Along railroad tracks (north-south) until cleanup levels are met; (b) Toward Building 230 (west) just under elevated loading dock if structural integrity is not compromised; (c) Toward parking lot (east) fill area just to the site boundary. This RU is ~~not within the planned Crissy Marsh expansion area, and~~ ~~is~~ directly adjacent to ~~an~~ existing ~~b~~Building 230 that will continue to be used (as described in Section 2.3.1 as the Presidio Archaeology Laboratory) until Crissy Marsh expansion into this area is implemented in the future; therefore, only Backfill Option C (complete backfill to match existing conditions) will be considered and costed for this RU in order to restore the site to current conditions consistent with continued use of the building.

As stated above, it is anticipated that conventional excavation and dewatering techniques would be able to remove the majority of petroleum-affected soils and groundwater within these RUs, including smear zone contamination that may continue to act as a source of contamination to groundwater if not completely removed. However, if excavation technologies cannot remove all petroleum contamination in and above this zone, prior to backfilling the excavation under Backfill Option C (complete backfill to match existing conditions), an oxygen release product (e.g., Oxygen Release Compound® [ORC®] or equivalent technology as described in Section 5.1.2.4 above) could be placed and mixed within the top several feet of the saturated zone/water table interface to treat residual soil and groundwater contaminants. Application of an oxygen release product within excavations is not anticipated to be necessary in order to achieve

cleanup levels within these RUs. Therefore, this technology is not included as a component of the excavation alternative at this time, but would be considered as a contingency in the field based on (1) potential technical limitations of removing visible/field-measurable organic COC contamination using standard excavation and dewatering techniques, and (2) RU-specific reuse considerations (i.e., it would not be considered for Backfill Options A and B within RUs where the Crissy Marsh expansion may occur and ecological receptors could potentially come in contact with the oxygen release product).

Offsite disposal of excavated petroleum-affected soils at an approved offsite disposal facility is an effective and implementable technology. Many different types of landfill disposal facilities are available in California that accept petroleum-affected soils.

For all Soil and Groundwater RUs for which excavation is implemented, groundwater monitoring would be conducted at one or more downgradient well or piezometer location depending on RU-specific conditions in order to monitor concentration trends of COCs and assess the effectiveness of the remedy. The proposed Groundwater Monitoring Program is summarized in Table 7, and monitoring locations are shown on Plate 21.

Excavation and offsite disposal is retained for further consideration for all Soil and Groundwater RUs (except inaccessible Building 228 RU) in combination with other technologies.

5.2 Corrective Action Alternatives Considered

Based on the screening of potential remedial technologies for soil and groundwater at the Building 207/231 CAP Area described above, the following corrective action alternatives have been assembled from the technologies retained for further consideration for evaluation and comparison for the RUs:

(1) No Action;

(2) Capping, Land Use Controls, and Groundwater Monitoring; and/or

(3) Excavation, Offsite Disposal of Soil, and Groundwater Monitoring.

The components of each of these three alternatives are described in the following sections.

Groundwater Monitoring

Groundwater monitoring would be included as a component of Alternatives 2 and 3. Table 7 and Plate 21 present the Groundwater Monitoring Program for these alternatives for each of the RUs and corrective action alternatives as follows:

- Suitability of current wells for pre-construction and/or post-construction monitoring (e.g., detections of COCs above cleanup levels, location with respect to remedial units at the Site, water-bearing zone/aquifer they are located within);
- Designation of wells to be abandoned during construction that are not suitable for use in the monitoring programs;
- Identification of wells to be installed during construction for the Post-Construction Monitoring Program;
- Descriptions of the Pre-Construction and Post-Construction Monitoring Program Criteria (e.g., COCs, analyses to be performed, objectives of the program, monitoring frequency and duration, and criteria for cessation of monitoring and abandonment).

In general, the objectives of the monitoring programs, criteria for their cessation, and identification of wells for abandonment are as follows (and are described in further detail in Sections 6.1 and 6.5, and Table 7):

- Arsenic in groundwater and associated redox parameters (indicators of reducing conditions) will be included in the proposed corrective action alternative monitoring program for the first year for all alternatives for purposes of further evaluation consistent with the Arsenic in

Groundwater Tech Memo (*MACTEC, 2006*) and adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2004b; T&R, 2005*). ~~The data will also be reviewed to further evaluate the relationship between arsenic concentrations, the hydrocarbon plume, Bay Mud, or other factors that affect redox conditions and therefore, the solubility of arsenic in groundwater. This data evaluation process, which will include statistical and spatial data analysis, will be further described in the CAP Implementation Work Plan, which will incorporate additional groundwater data that will be collected as part of the ongoing groundwater monitoring program.~~

- Pre-Construction Monitoring Program: 10 existing wells (selected due to prior detections of RU-specific COCs and/or arsenic above cleanup levels) will be sampled during one round of monitoring (one event only) to further establish pre-construction baseline conditions of (1) RU-specific petroleum-related COC concentration trends, and (2) Site-wide arsenic and associated redox parameter trends.

- Post-Construction Monitoring Program: 11~~8~~ wells (5~~3~~ existing wells and 6~~5~~ new wells; 1 or more of which are located downgradient of each RU, and 1 located upgradient of the Site) will be sampled to assess post-construction remedy effectiveness and achievement of cleanup levels as follows:

Excavation Alternative

Year 1—Monitor for RU-specific COCs, arsenic and associated redox parameters on a quarterly basis (4 events). If COCs are not below cleanup levels during 4 consecutive monitoring events~~quarters~~ in the first year, monitor semi-annually thereafter for RU-specific COCs only.

After Year 1—Cease monitoring after 4 consecutive events during which COCs are detected below cleanup levels upon regulatory approval.

Capping/Land Use Control Alternative

Year 1—Monitor for RU-specific COCs, arsenic and associated redox parameters during one event (on an annual basis). Monitor annually thereafter for RU-specific COCs only.

Years 2 through 10—Cease monitoring after 4 consecutive events during which COCs are detected below cleanup levels upon regulatory approval.

- Wells Targeted for Abandonment/Destruction: Table 7 and Plate 21 identify (1) the 40 existing wells/piezometers that are not suitably located for pre- or post-construction monitoring, and (2) the 7 existing wells that are not suitably located for post-construction monitoring, that will be abandoned during construction and implementation of the recommended corrective action alternatives upon regulatory approval. Well abandonment will be performed in accordance with State of California Water Well Standards and DPH requirements, with the exception of using neat bentonite to backfill the hole because this material would be more compatible with future restoration of the Crissy Marsh than concrete.

For purposes of developing cost estimates, the following groundwater monitoring and sampling program was assumed:

- Excavation Alternative: Groundwater samples including QA/QC samples (duplicates, equipment blanks, and trip blanks) will be collected on a quarterly basis for the 1st year, and semi-annually for the 2nd and 3rd years. For petroleum-related COCs (e.g., TPH, BTEX), if concentrations are below cleanup levels for four consecutive sampling rounds, it is proposed that monitoring for those COCs cease. Arsenic and associated redox parameters will be monitored for four sampling events only in the first year to evaluate if concentrations show trends and to refine the conceptual model for arsenic in groundwater. Groundwater elevations will be measured during each sampling event in all monitored wells.

- Capping and Land Use Control Alternative: Groundwater samples including QA/QC samples (duplicates, equipment blanks, and trip blanks) will be collected on an annual basis for 10 years. For petroleum-related COCs (e.g., TPH, BTEX), if concentrations are below cleanup levels for four consecutive sampling rounds, it is proposed that monitoring for those COCs cease. Arsenic will be monitored for four sampling events only in the first year to evaluate if concentrations show trends and to refine the conceptual model for arsenic in groundwater. Groundwater elevations will be measured during each sampling event in all monitored wells.

Consideration of Cultural Resources, Historical Resources, Potential Crissy Marsh and Tennessee Hollow Riparian Corridor Expansions, Replacement of the Doyle Drive/Highway 101 Overpass

The following resources and potential future uses of the Building 207/231 CAP Site were considered in the development of corrective action alternatives as follows:

- Cultural and Historic Resources: Potential impacts on cultural and historic resources that are known to be or may be present within these RUs during implementation of the corrective action alternative (e.g., intrusive activities in the Building 228 and adjacent historic wall area) would be minimized by (1) conducting a pre-construction archaeological investigation (described in Section 2.4); (2) requiring archaeological monitoring during intrusive activities to prevent adverse impacts; and (3) developing and recommending corrective action alternatives for RUs with identified historic resources that would not adversely affect their integrity (e.g., capping instead of excavation).

- Potential Crissy Marsh and Tennessee Hollow Riparian Corridor Expansions: Cleanup levels protective of these potential future uses as well as current uses were developed and used to define remedial units and corrective action alternatives. In addition, a range of backfilling options that would accommodate current and potential future uses were developed and costed for each RU as appropriate, and include: Backfill Option A—Open excavation with semi-permanent drainage

system to prevent overflow with stabilization/restoration of the excavation area and replacement of existing roadways as necessary; Backfill Option B—Partial backfill of excavation to above water table and stabilization with materials (such as sand and dune grasses) compatible with future restoration and replacement of existing roadways as necessary and installation of semi-permanent drainage system; Backfill Option C—Complete backfill of excavation and restoration of site to match existing grade and conditions and replacement of existing roadways as necessary.

- Replacement of the Doyle Drive/Highway 101 Overpass: Corrective actions to remediate contamination and replace roadways and associated structures under existing site conditions were considered, as well as for the potential Doyle Drive replacement alternatives.

The applicable RUs and RU-specific considerations for each of the alternatives are summarized in the following tables:

FORMER BUILDING 207 AREA (INCLUDING FORMER BUILDING 208 SUMP)		
ALTERNATIVE 1 **No Action**	**ALTERNATIVE 2** **Capping, Land Use Controls, Groundwater Monitoring**	**ALTERNATIVE 3** **Excavation, Offsite Disposal of Soil, Groundwater Monitoring**
√ INCLUDED FOR COMPARISON PURPOSES (Not Anticipated to be Effective or Implementable from an Administrative Perspective)	√ EFFECTIVE & IMPLEMENTABLE (If Crissy Marsh Expansion Does Not Occur) • <u>RU occurs in open paved area and is not adjacent to any structures</u>. Existing pavement over this RU could be improved and maintained as a cap. • <u>A long-term LUC could be implemented</u> to maintain current uses of this area if Crissy Marsh expansion does not occur. • <u>Groundwater monitoring would be included for this RU</u> to monitor concentration trends of COCs and assess the effectiveness of the remedy.	√ EFFECTIVE & IMPLEMENTABLE • <u>RU occurs in open paved area and is not adjacent to any structures</u>. This RU is accessible for excavation. • <u>All Backfill Options</u> would be applicable. This RU is within the Crissy Marsh expansion area. • <u>Groundwater monitoring would be included for this RU</u> to verify excavation into Bay Mud removed the source of COCs in soil that is currently causing exceedances of cleanup levels in groundwater.

FORMER BUILDING 38, 38-A, AND GARAGE AREA		
ALTERNATIVE 1 **No Action**	**ALTERNATIVE 2** **Capping, Land Use Controls, Groundwater Monitoring**	**ALTERNATIVE 3** **Excavation, Offsite Disposal of Soil, Groundwater Monitoring**
√INCLUDED FOR COMPARISON PURPOSES (Not Anticipated to be Effective or Implementable from an Administrative Perspective)	√EFFECTIVE & IMPLEMENTABLE (If Crissy Marsh Expansion Does Not Occur) • RU occurs in open paved area and is not adjacent to any structures. Existing pavement over this RU could be improved and maintained as a cap. • A long-term LUC could be implemented to maintain current uses of this area if Crissy Marsh expansion does not occur. • Groundwater monitoring would be included for this RU to monitor concentration trends of COCs and assess the effectiveness of the remedy.	√EFFECTIVE & IMPLEMENTABLE • RU occurs in open paved area and is not adjacent to any structures. This RU is accessible for excavation. • All Backfill Options would be applicable. This RU is within the Crissy Marsh expansion area. • Groundwater monitoring would be included for this RU to verify excavation into Bay Mud removed the source of COCs in soil that is currently causing exceedances of cleanup levels in groundwater.

EXISTING BUILDING 231 AREA		
ALTERNATIVE 1 **No Action**	**ALTERNATIVE 2** **Capping, Land Use Controls, Groundwater Monitoring**	**ALTERNATIVE 3** **Excavation, Offsite Disposal of Soil, Groundwater Monitoring**
√ INCLUDED FOR COMPARISON PURPOSES (Not Anticipated to be Effective or Implementable from an Administrative Perspective)	√ EFFECTIVE & IMPLEMENTABLE (If Crissy Marsh Expansion Does Not Occur) • RU extends beneath paved area and existing Building 231. Existing pavement over this RU and building foundation could be improved and maintained as a cap. • A long-term LUC could be implemented to maintain current uses of this area if Crissy Marsh expansion does not occur. • Groundwater monitoring would be included for this RU to monitor concentration trends of COCs and assess the effectiveness of the remedy.	√ EFFECTIVE & IMPLEMENTABLE • RU extends beneath existing Building 231 that has not been designated for preservation. In order to access this RU for excavation, the building will be demolished. • All Backfill Options would be applicable. This RU is within the Crissy Marsh expansion area that is planned to extend just north of the historic wall. • Groundwater monitoring would be included for this RU to verify excavation into Bay Mud removed the source of COCs in soil that is currently causing exceedances of cleanup levels in groundwater.

EXISTING BUILDING 228 AREA		
ALTERNATIVE 1 **No Action**	**ALTERNATIVE 2** **Capping, Land Use Controls, Groundwater Monitoring**	**ALTERNATIVE 3** **Excavation, Offsite Disposal of Soil, Groundwater Monitoring**
~~√~~INCLUDED FOR COMPARISON PURPOSES (Not Anticipated to be Effective or Implementable from an Administrative Perspective)	~~√~~EFFECTIVE & IMPLEMENTABLE • RU abuts a historic wall & historic Building 228 designated for preservation. Existing pavement over this RU and building foundation could be improved and maintained as a cap. • A long-term LUC could be implemented to maintain current uses of this area. Crissy Marsh expansion is not planned to extend as far south as this RU. • Groundwater monitoring would be included for this RU to monitor concentration trends of COCs and assess the effectiveness of the remedy. • In situ injection of oxygen release product would be included to remediate COCs in soil and groundwater within this small RU that occurs directly upgradient of the Building 231 RU that could potentially be re-contaminated. If follow-up confirmation sampling and groundwater monitoring determines this technology was effective in reducing COCs below cleanup levels, the LUC would be lifted.	NOT IMPLEMENTABLE • RU abuts a historic wall & historic Building 228 designated for preservation. This RU could not be excavated without damaging these structures.

EXISTING BUILDING 230 AREA		
ALTERNATIVE 1 **No Action**	**ALTERNATIVE 2** **Capping, Land Use Controls, Groundwater Monitoring**	**ALTERNATIVE 3** **Excavation, Offsite Disposal of Soil**
√INCLUDED FOR COMPARISON PURPOSES (Not Anticipated to be Effective or Implementable from Administrative Perspective)	√EFFECTIVE & IMPLEMENTABLE • RU extends beneath paved area adjacent to existing Building 230. Existing pavement over this RU could be improved and maintained as a cap. • A long-term LUC could be implemented to maintain current uses of this area. • Groundwater monitoring would be included for this RU to verify there are no groundwater impacts from the presence of COCs in soil.	√EFFECTIVE & IMPLEMENTABLE • RU is adjacent to existing Building 231. However, it is accessible from the east and is limited in extent (not assumed to extend beneath the building foundation). If COCs are found to extend beneath building during excavation, remedy would need to be reassessed (e.g., consider building demolition and complete excavation or capping/LUCs). • Only Backfill Option C (complete backfill to match existing site conditions) would be applicable. Building 230 lies between the RU and Crissy Marsh expansion that is not planned to extend this far east. • Groundwater monitoring would be included for this RU to verify there are no groundwater impacts from the presence of COCs in soil.

In accordance with Task 13 of RWQCB Order R2-2003-0080, a Five-Year Status Report, which evaluates the effectiveness of this CAP for groundwater, will be completed and submitted to the RWQCB for approval. In the Five-Year Status Report, groundwater conditions at the Building 207/231 Area will be evaluated and future corrective actions will be assessed. If cleanup levels for all COCs are achieved within the 5-year monitoring period, the groundwater monitoring program will be discontinued and the LUC related to groundwater contamination will be rescinded as described in further detail in Section 6.5.

The main components of these alternatives are summarized below.

5.2.1 Alternative 1—No Action

- This alternative takes no action to address site contaminants; therefore, there no components associated with its implementation.

5.2.2 Alternative 2—Capping, Land Use Controls, Groundwater Monitoring

- Capping: (1) Improvements to existing surface barriers covering the RUs (e.g., structural foundations, pavement) as necessary to prevent soil disturbance and exposure to contaminants; and/or (2) Installation of new capping material as necessary; and (3) Long-term inspection and maintenance of capping materials (for a period of 30 years for costing purposes). For RUs that extend beneath existing buildings or other occupied or potentially occupies structures that are designated to be preserved, the existing building foundations and adjacent areas would be inspected and assessed to determine the need for improvements (e.g., sealing the flooring and any conduits to the subsurface, monitoring indoor air quality) to prevent occupant exposure to volatile COCs in vadose zone soils that may intrude into the building. These measures would be implemented in accordance with DTSC/Cal EPA's Interim Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air, December 15, 2004, revised February 7, 2005. For the inaccessible Building 228 RU that can only be capped because excavation and soil removal would damage the historic building and wall, an oxygen release product would be applied using direct push technology within each limited portion of the RU in order to remediate COCs above cleanup levels that occur upgradient of Building 231 RU that could potentially be re-contaminated. If follow-up confirmation sampling and groundwater monitoring determines this technology was effective in reducing COCs below cleanup levels, the LUC would be lifted.
- Land Use Controls: (1) Preparation of a site-specific addendum to the LUC Master Reference Report for the Presidio to designate a permanent LUC for the area in conjunction with

maintaining the cap; (2) Conducting a review of the protectiveness of the corrective action alternative every 5 years; and (3) Preparation of 5-Year Review Reports.

- Groundwater Monitoring: (1) Continued monitoring of existing and new wells indicated in Table 7 and shown on Plate 21 quarterly for the first year, and annually thereafter for petroleum-related COCs, arsenic, and redox parameters to (a) verify COC concentrations in groundwater are not migrating offsite, and (b) assess whether concentrations of COCs in wells and piezometers at the site show trends over time. Groundwater samples including quality assurance/quality control (QA/QC) samples (duplicates, equipment blanks and trip blanks) will be collected, and results will be presented in the Presidio-Wide Semi-Annual Groundwater Monitoring Reports, (2) After all petroleum-related COCs and arsenic are demonstrated to be below cleanup levels for four consecutive sampling rounds, monitoring will be discontinued (with RWQCB approval) and clean closure with regard to groundwater contamination will be documented in a site closure report, and (3) Abandonment of wells, as applicable, upon RWQCB approval. ~~All RUs for which capping is implemented will include: (1) Annual monitoring of COCs downgradient of RUs for a period up to 10 years to monitor COC concentration trends and verify COC concentrations are decreasing and are not migrating offsite; (2) monitoring for arsenic and redox parameters in groundwater during the first year only for purposes of further evaluation consistent with the adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2004b; T&R, 2005*); and (3) Preparation of semi-annual groundwater monitoring reports.~~

5.2.3 Alternative 3—Excavation, Offsite Disposal of Soil, and Groundwater Monitoring

- Excavation and Offsite Disposal of Soil: (1) Removal of pavement and landscaped areas to provide access to Soil RUs as necessary; (2) Pre-remedial archaeological trenching as necessary and/or archaeological monitoring during excavation; (3) Excavation of soil containing COCs above cleanup levels into the Bay Mud and stockpiling soil onsite while sampling for waste

characterization purposes; (4) Dewatering as necessary within the excavation to remove as much visible/field-measurable organic COC contamination within the saturated zone as possible; (5) Confirmation soil sampling of the excavation sidewalls and bottom with further excavation of soil if necessary until contaminants are below cleanup levels or to the extent practicable based on structural or other technical constraints; (6) Backfilling excavations and restoring the area for its intended reuse via one of three options (*Backfill Option A*: Open excavation with semi-permanent drainage system to prevent overflow with stabilization/restoration of the excavation area and replacement of existing roadways as necessary; *Backfill Option B*: Partial backfill of excavation to above water table and stabilization with materials compatible with future restoration and replacement of existing roadways as necessary and installation of semi-permanent drainage system; *Backfill Option C*: Complete backfill of excavation and restoration of site to match existing grade and conditions and replacement of existing roadways as necessary); (7) Decontamination and recycling of any surface structures (asphalt, pavement, concrete, etc.) to the extent practicable; (8) Loading stockpiled and characterized soil into trucks and transporting for offsite disposal at a permitted landfill facility.

- Groundwater Monitoring: All RUs for which excavation is implemented will include: (1) Continued monitoring of existing and new wells indicated in Table 7 and shown on Plate 21 quarterly for the first year for petroleum-related COCs, arsenic and redox parameters); semi-annually thereafter for petroleum-related COCs; and annually thereafter for arsenic and redox parameters to (a) verify COC concentrations in groundwater are not migrating offsite, and (b) assess whether concentrations of COCs in wells and piezometers at the site show trends over time. Groundwater samples including quality assurance/quality control (QA/QC) samples (duplicates, equipment blanks and trip blanks) will be collected, and results will be presented in the Presidio-Wide Semi-Annual Groundwater Monitoring Reports, (2) After all petroleum-related COCs and arsenic are demonstrated to be below cleanup levels for four consecutive sampling

rounds, monitoring will be discontinued (subject to RWQCB approval), and clean closure with regard to groundwater contamination will be documented in a site closure report. ~~(1) Monitoring of COCs in downgradient wells on a quarterly basis for COCs to verify that contaminant concentrations are decreasing and that contaminants in groundwater are not migrating offsite for four consecutive quarters (one year) and semi-annually thereafter; (2) After all COCs are demonstrated to be below cleanup levels for four consecutive monitoring events, monitoring would cease and clean closure with regards to groundwater contamination would be documented in a site closure report; (3) Preparation of semi-annual groundwater monitoring reports; and (4) Assessment of the need for Land Use Controls if all soil containing COCs above cleanup levels is not removed. For the purposes of costing this component of the excavation alternative, the following groundwater monitoring sequence is assumed for a period of 3 years for all Groundwater RUs: Year 1 – Quarterly monitoring; Years 2 and 3 – Semi-annual monitoring. Arsenic in groundwater and associated redox parameters will be analyzed in the first year for purposes of further evaluation consistent with the adjacent former Building 1065 and Commissary PX Site CAPs (*MACTEC, 2004b; T&R, 2005*).~~

5.3 Criteria for the Evaluation of Corrective Action Alternatives

The three general criteria described in Section 5.1.2 that were used to screen potential remedial technologies – (1) effectiveness, (2) implementability, and (3) relative cost – are also applied in evaluating and comparing the corrective action alternatives but to a greater degree of detail as follows:

- Effectiveness—Site-Specific Applicability; Ability to Achieve RAOs;
- Implementability—Constructability; Timeliness; Impacts to Ongoing Operations and Resources; and

- Cost—Capital Costs; Long Term Operations and Maintenance (O&M) Costs; and Total Net Present Value Costs.

These criteria encompass the degree to which the alternative meets the RAOs described in Section 4.1 and (1) mitigates potential adverse affects related to releases of petroleum hydrocarbons at the Site; (2) protects human health, ecological receptors, water quality, culturally sensitive areas; (3) complies with State and federal environmental laws; (4) controls long-term risks, source contamination, and volume of contaminants (provides for permanent "clean closure" of the Site); and (5) is likely to be acceptable to the regulatory agencies and public stakeholders. The Draft Building 207/231 Area CAP will be made available for stakeholder review and comment. All comments received will be considered prior to finalizing the CAP, and comments will be summarized and responded to in a Responsiveness Summary that will be included as Appendix C of the final CAP document.

5.4 Evaluation of Corrective Action Alternatives

The comparative evaluation of corrective action alternatives is presented below and summarized in Table 6 for each of the five RUs.

5.4.1 Alternative 1—No Action

Alternative 1 provides no additional control or protection to human health or the environment for the contamination that exists within the Building 207/231 CAP Area RUs. Soil would not be subject to any corrective actions to prevent potential exposures to COCs above cleanup levels and mitigate the potential for COCs in soil to continue to act as a source of contamination to groundwater. In addition, groundwater would not be monitored to assess any impacts due to existing contamination and all existing potential exposure pathways would remain uncontrolled. Therefore, this alternative would not prevent visitor, tenant, or ecological receptor (if Crissy Marsh is expanded into this area) exposures, would not protect against impacts to groundwater, and therefore would not protect human health or promote safety or

protectiveness of the environment. The “no action” alternative provides no technical effectiveness, since no corrective action is undertaken and COCs would not be reduced. There are no costs associated with this alternative although it fails to address any site impacts of the petroleum releases.

- Effectiveness—Would not mitigate risks or comply with environmental laws.
- Implementability—Would not be implementable from an administrative perspective because it takes no action to mitigate risks or comply with environmental laws. Easy level of effort to implement from a technical perspective because no action would be taken.
- Cost—No cost.

5.4.2 Alternative 2—Capping, Land Use Controls, Groundwater Monitoring

The main components of this alternative are described in Section 5.2.2, and estimated costs associated with its implementation are presented in Appendix B for each applicable RU. Alternative 2 improves on, replaces as necessary, and maintains existing asphalt and concrete foundation caps over the Soil RUs to isolate the contaminated soil from human exposure. For the RUs shown on Plate 19a~~A~~, Crissy Marsh may be extended into this area; therefore, this alternative would not be consistent with this potential reuse for these RUs (Former Buildings 207 and 38, 38-A, and Garage Areas). However, it is unknown at this time whether the Crissy Marsh or Tennessee Hollow Riparian Corridor will be extended into this area, so this alternative is retained for comparison and costs are estimated for its implementation. This alternative would be consistent with the current and planned reuses of parking areas and buildings and is retained for comparison costs are estimated for its implementation. Because COCs above cleanup levels are not removed via capping, this alternative would include the development and implementation of LUCs to safeguard the cap; provide advance notice of site conditions in the event of future ground disturbing activity; and restrict future land uses to those compatible with safeguarding the integrity of the cap. For the purposes of preparing cost estimates for this alternative, it is assumed cap inspection and maintenance

would be performed on a yearly basis for a period of 30 years (the maximum time period for costing annual long-term operations and maintenance costs recommended by USEPA [*USEPA, 2000*]).

Based on the definition of Soil RUs presented in Section 4.4, the estimated areal extent of soil to be capped and existing site conditions specific to each RU is:

- **Former Building 207 Area (Including Former Building 208 Sump)** — Two adjacent areas of soil contamination co-located with an area of groundwater contamination believed to be associated with the former Building 207 USTs and former Building 208 sump (Plate 19a~~A~~), comprising approximately 7,000 square feet in an open ~~grassy~~ area with no existing surface structures.

- **Former Building 38, 38-A, Garage Area** — One area of soil contamination co-located with an area of groundwater contamination believed to be associated with use of the former Building 38, 38-A and garage areas (Plate 19a~~A~~), comprising approximately 3,000 square feet under a paved asphalt parking area.

- **Existing Building 231 Area** — One area of soil contamination co-located with an area of groundwater contamination believed to be associated with the former Building 231 USTs located north of the historic wall, to below the Southern Doyle Drive/Highway 101 Overpass (Plate 19b~~B~~), comprising approximately 33,400 square feet under a paved asphalt parking area and approximate 7,000-square foot existing building.

- **Existing Building 228 Area** — Two areas of soil contamination co-located with an area of groundwater contamination believed to be associated with the former Building 228 USTs (Plate 19b~~B~~): (1) One area of soil contamination located between Building 228 and the historic wall within the excavation associated with the former 228 USTs comprising approximately 330 square feet under weathered asphalt pavement; (2) Another area of soil contamination located

immediately south of Building 228 within the former excavation associated with the FDS lines comprising approximately 80 square feet under weathered asphalt pavement. Because the Building 228 RU occurs directly upgradient of the Building 231 RU and the source of petroleum-related COCs would not be removed under this alternative and could potentially re-contaminate the Building 231 RU, a one-time in situ injection of an oxygen release product slurry on a closely-spaced grid using direct push technology within the saturated zone in this RU would also be implemented. The effectiveness of the in situ injection of oxygen release product in reducing groundwater COCs below cleanup levels will be assessed (1) during groundwater monitoring of downgradient wells for COCs over a 2-year period following injection, and (2) after the 2-year period by collecting 10 in situ soil confirmation samples and 4 in situ groundwater confirmation samples using direct push technology. The need for additional injection or implementation of other technologies consistent with mitigating or preventing migration of groundwater containing COCs above cleanup levels will also be assessed. Details regarding the need for, implementation, and duration of these contingencies would be described in a supplemental report based on the results of post-injection groundwater monitoring and in situ soil and groundwater confirmation sampling. If follow-up groundwater monitoring and confirmation sampling conducted 2 years after in situ injection determines this technology was effective in reducing COCs below cleanup levels, the LUC would be lifted. ~~in situ injection of an oxygen release product using direct push technology within this RU would be included. If follow-up confirmation sampling and groundwater monitoring determines this technology was effective in reducing COCs below cleanup levels, the LUC would be lifted~~.

- **Existing Building 230 Area** — One area of soil contamination believed to be associated with loading dock railroad activities (Plate 19b~~B~~) comprising approximately 1,800 square feet under asphalt pavement.

This alternative also includes annual groundwater monitoring downgradient of each Groundwater RU for petroleum-related COCs, and monitoring of wells for arsenic and associated redox parameters in order to verify that contaminant concentrations are decreasing and that contaminants in groundwater are not migrating offsite. For the purposes of preparing cost estimates for this alternative, it is assumed annual groundwater monitoring for RU-specific COCs would continue for a period of 10 years downgradient of each Groundwater RU. Monitoring for arsenic and associated redox parameters would be conducted during the first year. Because the Site is in the vicinity of archaeologically sensitive areas, intrusive work at this Site (e.g., replacement of pavement, destruction/installation of monitoring wells) would be monitored as outlined in Section 6.4.

Capping of contaminants would be protective of human health, safety, and the environment, as it would eliminate the potential for contaminant exposure through soil ingestion, dermal contact, and inhalation. LUCs would also prevent direct contact with the contaminated soil and future land uses inconsistent with levels of contamination remaining onsite and establish procedures for the management of contaminated soil, if encountered in the future. This alternative is technically effective if caps are maintained and LUCs imposed. Groundwater monitoring would provide a long-term assessment of groundwater quality. Although no active treatment of soil would be performed, the potential for migration of COCs from soil into groundwater would be reduced based on the reduced potential for surface water infiltration provided by the cover. Capping with LUCs is readily implementable, particularly because the majority of the applicable Soil RUs are already capped with asphalt and concrete (i.e., pavement and building foundations). Capping improvements (e.g., inspections, indoor air quality monitoring, resealing or repaving asphalt) would involve some design and construction improvements. The total costs for this alternative for the applicable RUs are presented in Appendix B, and summarized in Table 6.

- Effectiveness—Would mitigate risks and comply with environmental laws, but would not permanently remove COCs to provide ‘clean closure’. However, the majority of the RUs are covered by pavement and buildings and used commercially, and there are no residential or

ecological receptors within this area, so this alternative would provide a low cost option for mitigating risks under current reuses until the time when/if the site reuses are modified.

- Implementability—Would be implementable from an administrative perspective because caps and LUCs would be maintained and comply with environmental laws. Easy level of effort to implement from a technical perspective.

- Cost—Low-to-moderate cost.

5.4.3 Alternative 3—Excavation, Offsite Disposal of Soil, and Groundwater Monitoring

The main components of this alternative are described in Section 5.2.3, and estimated costs associated with its implementation are presented in Appendix B for each applicable RU. Alternative 3 involves excavation and removal of all contaminated soil where COCs are present above cleanup levels from Soil RUs, followed by waste characterization, transport to, and disposal of waste materials at an approved offsite landfill disposal facility. Because the Site is in the vicinity of archaeologically sensitive areas, work at this Site (e.g., pavement removal, excavation) would be monitored as outlined in Section 6.4. Based on the definition of Soil RUs presented in Section 4.4, the estimated volume of soil to be excavated from each RU is:

- **Former Building 207 Area (Including Former Building 208 Sump)** — Two areas of soil contamination co-located with an area of groundwater contamination associated with the former Building 207 USTs (Plate 19a~~A~~): (1) One soil area is located to the north beneath former Building 207 Exchange Service Station Area located in the vadose zone soils from 3 to 3.5 feet bgs, and comprising approximately 1,100 cubic yards of soil, and (2) another soil area is located to the south in and around the former sump associated with former Building 208 located in saturated soil from 5 to 7.5 feet bgs, and comprising approximately 30 cubic yards of soil.

- **<u>Former Building 38, 38-A, Garage Area</u>** — One area of soil contamination co-located with an area of groundwater contamination associated with use of the former Building 38, 38-A and garage areas (Plate 19a~~A~~) located in unsaturated and saturated zone soils between 0.5 and 10 feet bgs, and comprising approximately 670 cubic yards of soil.

- **<u>Existing Building 231 Area</u>** — One area of soil contamination co-located with an area of groundwater contamination associated with the former Building 231 USTs (Plate 19b~~B~~) located north of the historic wall to below the Southern Doyle Drive/Highway 101 Overpass (Plate 19b~~B~~), located in unsaturated and saturated zone soils between 0.5 to 10 feet bgs, and comprising approximately 7,200~~190~~ cubic yards of soil. To the north, the excavation would extend to near the Doyle Drive overpass (Plate 20b), but would not extend beneath this area. A Land Use Control for this area would be in place until the time when the soil is exposed during future development of the Site, at which point it would be excavated. A geotextile fabric would be emplaced during excavation of the northern portion of the RU to mark the extent of the excavation.

- **<u>Existing Building 228 Area</u>** — Two areas of soil contamination co-located with an area of groundwater contamination associated with the former Building 228 USTs (Plate 19b~~B~~): (1) One area of soil contamination located between Building 228 and the historic wall within the excavation associated with the former 228 USTs (Plate 19b~~B~~) located in unsaturated and saturated soil between 1 to 11 feet bgs, and comprising approximately 120 cubic yards of soil; (2) Another area of soil contamination located immediately south of Building 228 within the former excavation associated with the FDS lines (Plate 19b~~B~~) located in vadose zone soil at 6 feet bgs, and comprising approximately 30 cubic yards of soil.

- **Existing Building 230 Area** — One area of soil contamination associated with loading dock railroad activities (Plate 19b~~B~~) located in vadose zone soils between 3 to 5.5 feet bgs, and comprising approximately 400 cubic yards of soil.

During excavation, confirmation samples would be collected from the excavation floor and sidewalls to verify that soils exceeding cleanup criteria have been removed as described in Section 6.2. The need for (1) additional application of oxygen release product as a contingency via in situ injection and/or (2) implementation of interim LUCs will be performed if groundwater monitoring data indicates the excavation of source materials did not reduce groundwater COCs below cleanup levels would also be assessed. Details regarding the need for, implementation, and duration of these contingencies would be described in a supplemental report based on the results of post-construction groundwater monitoring.

This alternative also includes annual groundwater monitoring downgradient of each Groundwater RU for petroleum-related COCs, and monitoring for arsenic and associated redox parameters in order to verify that contaminant concentrations are decreasing and that contaminants in groundwater are not migrating offsite. For the purposes of preparing cost estimates for this alternative, the following groundwater monitoring sequence is assumed for a period of 3 years for all Groundwater RUs: Year 1—Quarterly monitoring; Years 2 and 3—Semi-annual monitoring.

For the purposes of preparing cost estimates for this alternative, it is assumed groundwater monitoring would be performed for the proposed monitoring well network shown on Plate 21 and summarized in Table 7~~downgradient of each Groundwater RU~~. Monitoring for arsenic and associated redox parameters would be conducted during the first year. Because the Site is in the vicinity of archaeologically sensitive areas, intrusive work at this Site (e.g., replacement of pavement, destruction/installation of monitoring wells) would be monitored as outlined in Section 6.4.

Excavation and removal of contaminated soil would be protective of human health, safety, and the environment, because the shallow soil contamination is removed, thereby eliminating potential human

and ecological exposures to contaminants. The excavated soil would be transported offsite to a facility approved to manage the waste. This remedy is technically effective and permanent. Contaminated soil is removed, thereby preventing worker and visitor exposures and impacts to groundwater. Although the volume of contaminants will not be reduced because the impacted material will not be treated, potential exposure of workers and the public to contaminated materials during excavation and loading for offsite transport would be mitigated by engineering and dust control measures. This alternative is implementable and no significant obstacles have been identified except for portions of some of the RUs that extend beneath existing buildings or historic structures designated to be preserved or abutting such structures as follows:

- Building 231 RU: The building will be demolished prior to excavation to allow for access of the entire RU that extends beneath the building, as well as the area between the building and historic wall.

- Building 228 RU: It is assumed the building and historic wall will be preserved and excavation can not be implemented without damaging these structures. This alternative is not considered for this RU.

- Building 230 RU: It is assumed the building will be preserved and excavation can be implemented adjacent to the building without damaging the structure.

The total costs for this alternative for the applicable RUs are presented in Appendix B, and summarized in Table 6.

- Effectiveness—Would mitigate risks and comply with environmental laws and permanently remove soil and groundwater containing COCs above cleanup levels to provide eventual 'clean closure' after a period of groundwater monitoring to confirm COCs are below cleanup levels in groundwater. Complete removal of COCs would also allow for restoration and expansion of

Crissy Marsh, the Tennessee Hollow Riparian Corridor, and Doyle Drive replacement roadways into the Site.

- Implementability—Would be implementable from an administrative perspective because it takes action to mitigate risks and comply with environmental laws. High level of effort to implement from a technical perspective.

- Cost—Moderate-to-high cost.

5.5 ~~Recommended~~ Selected Corrective Action Alternatives

The rationale presented below for ~~selection of the recommended~~ the selected corrective action alternatives is based on their~~its~~ ability to meet each of the evaluation criteria for each of the RUs is summarized in Table 6. Plates 20a and 20b show the locations of the corrective action alternative excavation and capping/LUC areas.

5.5.1 Former Building 207 Area (Including Building 208 Sump) Soil and Groundwater Remedial Units—Alternative 3 (Excavation, Offsite Disposal of Soil, and Groundwater Monitoring)

The ~~recommended~~ selected alternative for Former Building 207 Area co-~~l~~located Soil and Groundwater RUs is Alternative 3 (Excavation, Offsite Disposal of Soil, and Groundwater Monitoring). Under this alternative, all petroleum-contaminated soil would be removed and disposed of offsite at an approved disposal facility. Excavation would continue until soil confirmation sampling results indicate that cleanup levels are met within the excavation bottom and sidewalls according to provisions in Section 6.0. The excavation would be backfilled using one of the three options considered for this area where the Crissy Marsh expansion may occur. This alternative also includes groundwater monitoring of downgradient wells for petroleum-related COCs and arsenic and the eventual abandonment of these wells upon regulatory approval. Downgradient wells would be monitored for COCs to verify that contaminant concentrations are decreasing and that contaminants in groundwater are not migrating offsite until the

point in time when all COCs have been consistently below cleanup levels for four consecutive monitoring events. After all concentrations of petroleum-related COCs and arsenic in groundwater have been demonstrated to be below cleanup levels for four consecutive monitoring events, monitoring will be discontinued (subject to RWQCB approval) and clean closure with regard to groundwater contamination will be documented in a site closure report. For the purposes of costing this component of the excavation alternative, the following groundwater monitoring sequence is assumed for a period of 3 years for all Groundwater RUs under the Excavation Alternative: Year 1—Quarterly monitoring; Years 2 and 3—Semi-annual monitoring.

The total cost of this alternative ranges from $238,000 to $322,000~~317,000 to $360,000~~ depending on the backfilling option selected (Appendix B, Tables B-2, B-3, and B-4~~207-Excav-A, -B, -C~~) as compared to $207,000~~238,000~~ for Alternative 2 (Capping, Land Use Controls, and Groundwater Monitoring; Appendix B, Table B-1~~207-Cap-LUC~~) and no costs for Alternative 1 (No Action) which is not protective.

Alternative 3 is ~~recommended~~ selected for implementation at co-located Former Building 207 Area Soil and Groundwater RUs because it is technically effective and takes advantage of the opportunity to remove all contaminated soil and allow for eventual restoration of the area under the Crissy Marsh expansion, is readily implementable and cost-effective. Although this alternative is relatively high in cost, contaminated soil is removed permanently from the Site, thus eliminating the potential for future exposures. In addition, it is assumed that 'clean closure' of these RUs could be achieved within the 3 year period of groundwater monitoring assumed for costing purposes.

5.5.2 Former Building 38, 38-A, and Garage Area Soil and Groundwater Remedial Units—Alternative 3 (Excavation, Offsite Disposal of Soil, and Groundwater Monitoring)

The ~~recommended~~ selected alternative for Former Building 38, 38-A, and Garage Area co-~~l~~located Soil and Groundwater RUs is Alternative 3 (Excavation, Offsite Disposal of Soil, and Groundwater Monitoring). Under this alternative, all petroleum-contaminated soil would be removed and disposed of

offsite at an approved disposal facility. This RU extends beneath the Southern Doyle Drive / Highway 101 Overpass (Plate 20a). Excavation will be performed under the overpass based on these technical constraints in a manner that will not endanger the overpass structure in an attempt to remove all soil within the RU containing concentrations of COCs above cleanup levels. However, as a contingency, if it is determined during the remedial design or construction phases of the CAP implementation that is not possible to remove all contamination associated with this RU without impacting the structural integrity of the overpass, excavation of this RU or remaining inaccessible portions of this RU would be assessed in coordination with the Doyle Drive reconstruction efforts as described for the Building 231 Area RU. Excavation would continue until soil confirmation sampling results indicate that cleanup levels are met within the excavation bottom and sidewalls according to provisions in Section 6.0. The excavation would be backfilled using one of the three options considered for this area where the Crissy Marsh expansion may occur. This alternative also includes monitoring of downgradient wells for petroleum-related COCs and arsenic, and the eventual abandonment of these wells upon regulatory approval. Downgradient wells would be monitored until the point in time when all COCs have been consistently below cleanup levels for four consecutive monitoring events to (1) verify that contaminant concentrations are decreasing, and (2) that contaminants in groundwater are not migrating offsite. After all concentrations of petroleum-related COCs and arsenic in groundwater have been demonstrated to be below cleanup levels for four consecutive monitoring events, monitoring will be discontinued (subject to RWQCB approval) and clean closure with regard to groundwater contamination will be documented in a site closure report. For the purposes of costing this component of the excavation alternative, the following groundwater monitoring sequence is assumed for a period of 3 years for all Groundwater RUs under the Excavation Alternative: Year 1—Quarterly monitoring; Years 2 and 3—Semi-annual monitoring.

The total cost of this alternative ranges from $186,000 to $203,000~~243,000 to $249,000~~ depending on the backfilling option selected (Appendix B, Tables B-6, B-7, and B-8~~38-Excav-A, -B, -C~~) as compared to

$161,000~~188,000~~ for Alternative 2 (Capping, Land Use Controls, and Groundwater Monitoring; Appendix B, Table B-5~~38 Cap-LUC~~) and no costs for Alternative 1 (No Action) which is not protective.

Alternative 3 is ~~recommended~~ selected for implementation at co-located Former Building 38, 38-A, and Garage Area Soil and Groundwater RUs because it is technically effective and takes advantage of the opportunity to remove all contaminated soil and allow for eventual restoration of the area under the Crissy Marsh expansion, is readily implementable and cost-effective. Although this alternative is relatively high in cost, contaminated soil is removed permanently from the Site, thus eliminating the potential for future exposures. In addition, it is assumed that 'clean closure' of these RUs could be achieved after a period of 3 years of groundwater monitoring to confirm concentrations of COCs are below cleanup levels.

5.5.3 Existing Building 231 Area Soil and Groundwater Remedial Units—Alternative 3 (Excavation, Offsite Disposal of Soil, and Groundwater Monitoring)

The ~~recommended~~ selected alternative for Existing Building 231 Area co-~~l~~located Soil and Groundwater RUs (including the Former Building 271 Area as described in Section 4.4) is Alternative 3 (Excavation, Offsite Disposal of Soil, and Groundwater Monitoring). Under this alternative, the building would be demolished and all petroleum-contaminated soil would be removed (and to the extent possible in the southern portion of the RU that abuts the historic wall) and disposed of offsite at an approved disposal facility. Excavation would continue until soil confirmation sampling results indicate that cleanup levels are met within the excavation bottom and sidewalls according to provisions identified in Section 6.2 with the following exceptions:

- Northern Boundary of Building 231 RU (including the Former Building 271 Area): This portion of the RU abuts and extends beneath the Southern Doyle Drive / Highway 101 Overpass (Plates 20b and 20a). Excavation will be performed with the intent of removing as much contaminated soil as possible from the portion of the RU south of/abutting the overpass in a manner that will not endanger the overpass structure. Excavation will not be performed beneath the overpass at this time, but will be performed in

the future during construction and implementation of the selected Doyle Drive replacement alternative. A geomembrane will be installed against the excavation sidewall abutting the unexcavated overpass portion of the RU to mark the extent of the excavation, and a Land Use Control will be implemented for the area.

- Southern Boundary of Building 231 RU: This portion of the RU that abuts the historic wall designated for preservation (Plate 20b). Excavation will not extend beneath the wall and will be performed with the intent of removing as much contaminated soil as possible from this portion of the RU in a manner that will not endanger this structure. The contaminated soil that extends beneath the wall is included in the Building 228 Soil RU that will be capped and treated via in situ injection of oxygen release product.

This alternative also includes groundwater monitoring of downgradient wells for petroleum-related COCs and arsenic and the eventual abandonment of these wells upon regulatory approval. Downgradient wells would be monitored for COCs to verify that contaminant concentrations are decreasing and that contaminants in groundwater are not migrating offsite until the point in time when all COCs have been consistently below cleanup levels for four consecutive events. After all concentrations of petroleum-related COCs and arsenic in groundwater have been demonstrated to be below cleanup levels for four consecutive monitoring events, monitoring will be discontinued (subject to RWQCB approval) and clean closure with regard to groundwater contamination will be documented in a site closure report. For the purposes of costing this component of the excavation alternative, the following groundwater monitoring sequence is assumed for a period of 3 years for all Groundwater RUs: Year 1—Quarterly monitoring; Years 2 and 3—Semi-annual monitoring.

The total cost of this alternative ranges from $1,576,000 to $1,822,000~~1,516,000 to $1,742,000~~ depending on the backfilling option selected (Appendix B, Tables B-10, B-11, B-12~~231-Excav-A, -B, -C~~) as compared to $898,000~~697,000~~ for Alternative 2 (Capping, Land Use Controls, and Groundwater

Monitoring; Appendix B, Table B-9~~231-Cap-LUC~~) and no costs for Alternative 1 (No Action) which is not protective.

Alternative 3 is ~~recommended~~ selected for implementation at co-located Existing Building 231 Area Soil and Groundwater RUs because it is technically effective and takes advantage of the opportunity to remove the majority of contaminated soil and allow for eventual restoration of the area under the Crissy Marsh expansion, is readily implementable and cost-effective. Although this alternative is relatively high in cost, contaminated soil is removed permanently from the Site, thus eliminating the potential for future exposures. In addition, it is assumed that 'clean closure' of these RUs could be achieved after a period of 3 years of groundwater monitoring to confirm concentrations of COCs are below cleanup levels.

5.5.4 Existing Building 228 Area Soil and Groundwater Remedial Units—Alternative 2 (Capping, Land Use Controls, In Situ Injection of Oxygen Release Product, and Groundwater Monitoring)

The ~~recommended~~ selected alternative for Existing Building 228 Area co-~~l~~located Soil and Groundwater RUs is Alternative 2 (Capping, Land Use Controls, In Situ Injection of Oxygen Release Product, and Groundwater Monitoring). Under this alternative, the existing pavement outside the building and interior of the building would be inspected and monitored for capping improvements, and these improvements would be implemented and maintained. In addition, oxygen release product would be injected within the two portions of this RU (south and north of historic Building 228) using direct push technology. In situ injection would be implemented in order to remediate COCs that may extend beneath the building and historic wall that lie directly upgradient of and may potentially re-contaminate the Building 231 RU.

This alternative also includes groundwater monitoring of a downgradient well for petroleum-related COCs and arsenic and the eventual abandonment of this well upon regulatory approval. The downgradient well would be monitored for COCs to verify that contaminant concentrations are decreasing and that contaminants in groundwater are not migrating offsite until the point in time when all

COCs have been consistently below cleanup levels for four consecutive monitoring events. After all concentrations of petroleum-related COCs and arsenic in groundwater have been demonstrated to be below cleanup levels for four consecutive monitoring events, monitoring will be discontinued (subject to RWQCB approval) and clean closure with regard to groundwater contamination will be documented in a site closure report. For the purposes of costing this component of the capping alternative, annual groundwater monitoring would be conducted for a period of 10 years for RU-specific COCs, with monitoring of arsenic and associated redox parameters in the first year only. The monitoring duration and frequency would be assessed based on the results of the effectiveness of the in situ injection of oxygen release product in reducing groundwater COCs below cleanup levels over a 2-year period following injection.

This alternative also includes in situ confirmation sampling two years after the oxygen release product injection has been implemented (using the same bottom and sidewall sampling frequencies identified for the Excavation Alternative described in Section 6.2) to assess whether concentrations of COCs in this RU are below cleanup levels. The effectiveness of the in situ injection of oxygen release product in reducing groundwater COCs below cleanup levels will be assessed over a 2-year period following injection. The need for additional injection or implementation of other technologies consistent with mitigating or preventing migration of groundwater containing COCs above cleanup levels will also be assessed. Details regarding the need for, implementation, and duration of these contingencies would be described in a supplemental report based on the results of post-injection groundwater monitoring. If confirmation sampling and downgradient post-construction groundwater monitoring of this RU indicated concentrations of COCs are below cleanup levels, it is assumed that ‘clean closure’ of this RU would be obtained.

The total cost of this alternative is $189,000~~241,000~~ for Alternative 2 (Capping and Land Use Controls; Appendix B, Table B-13~~228-Cap-LUC~~) compared to no costs for Alternative 1 (No Action) which is not protective. The excavation alternative does not apply to this RU due to preservation of the historic

building and wall; contamination that is left in place beneath the wall will be treated using in situ injection of oxygen release product.

Alternative 2 is ~~recommended~~ selected for implementation at co-located Existing Building 228 Area Soil and Groundwater RUs because it is the only alternative that can be implemented without damaging the historic building and wall that are designated for preservation, is technically effective, is readily implementable and cost-effective. Although this alternative may not permanently remove contaminated soil from the Site, capping and long-term LUCs would eliminate the potential for future exposures to COCs remaining in soil and groundwater. In addition, remediation of residual contamination using in situ oxygen release product would be implemented in order to remediate COCs in soil and groundwater in this RU and prevent recontamination of the downgradient Building 231 RU.

5.5.5 Existing Building 230 Area Soil and Groundwater Remedial Units—Alternative 3 (Excavation and Offsite Disposal)

The ~~recommended~~ selected alternative for the Existing Building 230 Area Soil RU is Alternative 3 (Excavation and Offsite Disposal of Soil). Because groundwater associated with this Soil RU has not been sampled, groundwater monitoring of (1) a downgradient well would be performed as under the other Excavation Alternatives, and (2) two HydroPunch samples would be collected from the excavation after soil removal is complete to verify COCs detected in saturated soils above cleanup levels have not impacted groundwater. After all concentrations of petroleum-related COCs and arsenic in groundwater have been demonstrated to be below cleanup levels for four consecutive monitoring events, monitoring will be discontinued (subject to RWQCB approval) and clean closure with regard to groundwater contamination will be documented in a site closure report. Under this alternative, all of the petroleum-contaminated soil would be removed outside of the building footprint and disposed of offsite at an approved disposal facility. Excavation would continue until soil confirmation sampling results indicate that cleanup levels are met within the excavation bottom and sidewalls, ~~or adjacent to the building footprint~~ according to provisions in Section 6.0. The approximate limitations on extent of over-

excavation in this RU would be based on confirmation sampling as follows: (a) Along railroad tracks (north-south) until cleanup levels are met; (b) Toward Building 230 (west) just under elevated loading dock if structural integrity is not compromised; (c) Toward parking lot (east) fill area just to the site boundary. The total cost of this alternative is estimated at $223,000~~210,000~~ for Excavation with Backfilling Option C (complete backfill to match existing conditions because this RU is not within the potential Crissy Marsh expansion area; Appendix B, Table B-15~~230-Excav-C~~), as compared to $200,000~~189,000~~ for Alternative 2 (Capping, Land Use Controls, and Groundwater Monitoring; Appendix B, Table B-14~~230-Cap-LUC~~), and no costs for Alternative 1 (No Action) which is not protective.

Alternative 3 is ~~recommended~~ selected for implementation at the Existing Building 230 Area Soil RU because it is technically effective and takes advantage of the opportunity to remove all contaminated soil, is readily implementable and cost-effective. Although this alternative is relatively high in cost, contaminated soil is removed permanently from the Site, thus eliminating the potential for future exposures.

6.0 IMPLEMENTATION OF CORRECTIVE ACTION ALTERNATIVES

This section describes the tasks associated with implementation of the ~~recommended~~ selected alternatives, applicable laws and regulatory requirements, and the anticipated schedule. Implementation of the CAP alternatives including confirmation sampling, groundwater monitoring, and archaeological monitoring are also discussed below.

6.1 Corrective Action Implementation

The corrective actions set forth in Section 5.5.1 through 5.5.5 for the five RUs described in Section 4.4 will be implemented by the Trust. Upon regulatory agency approval of the Final CAP, a comprehensive implementation Work Plan (Building 207/231 Area CAP Work Plan) will be prepared for these RUs. The Building 207/231 CAP Work Plan that addresses the Soil and Groundwater RUs will include the details of the soil confirmation sampling and groundwater monitoring programs described in Section 5.5.

6.2 Soil Confirmation Sampling Program

Confirmation soil sampling will be conducted within each Soil RU under the ~~recommended~~ selected corrective action alternatives (Excavation for Building 207, 38, 231, and 230 RUs; Capping/Land Use Controls/Injection of Oxygen Release Product for Building 228 RU) as follows:

Excavation Alternative Confirmation Sampling: It is anticipated that after the impacted materials have been removed from within the excavation areas, the exposed land surface will consist of excavation "bottom" with the perimeter of the excavation having "sidewalls." Bottom sampling will be based on the actual size of the excavation with a minimum of one sample per 625 square feet (sf). A 25- by 25-foot sampling grid will be used to guide the collection of excavation bottom samples. Sidewalls will be sampled at the midpoint of the excavation's height (using best professional judgment for biasing sample location to any visible stained soil layers) every 25 feet of its lateral extent or to obtain at least one sample per excavation sidewall. The actual physical dimensions of the excavation will determine the number of

bottom and sidewall samples collected. At least one bottom and four sidewall samples will be collected from the excavation. As described in Section 5.5.3, for the Building 231 RU (which abuts the Southern Doyle Drive / Highway 101 Overpass to the north, and the historic wall designated for preservation to the south), excavation would only extend as far as is technically feasible without endangering these structures. Confirmation samples would be collected from the limits of the excavation in these areas using the same protocols described above to provide a record of potentially remaining contamination. The unexcavated soil in the northern portion of the RU would be excavated in the future during the Doyle Drive replacement construction phase in this area, and soil in the southern portion of the RU abutting the historic wall would be addressed under the adjacent Building 228 RU capping alternative.

Capping/Land Use Control/Injection of Oxygen Release Product Alternative Confirmation Sampling: ~~t~~Two years after the oxygen release product has been injected within the footprint of the Building 228 Soil RU, direct-push soil confirmation sampling within this RU will be conducted ~~on a 25- by 25-foot sampling grid, and will “step out” and extend 25 feet beyond~~ within and outside of the footprint of the RU ~~until COCs are below cleanup levels or the ground surface is inaccessible due to~~ considering the technical constraints of access due to the presence of existing buildings or other structural constraints. Details regarding the confirmation sampling would be described in a supplemental work plan based on the results of post-construction groundwater monitoring that assesses the effectiveness of oxygen release product injection in reducing petroleum-related COCs within the saturated zone of this RU. ~~The actual physical dimensions of the RU will determine the number of samples collected. At least one bottom and four ‘step out” (sidewall) samples will be collected from this RU.~~

All confirmation samples will be analyzed for one or more of the following COCs identified for each of the Soil RUs described in Section 4.4:

- PAHs by EPA Method 8270-SIM;
- ~~TPHg by EPA Method 8015 modified;~~

- TPH as gasoline, diesel, and fuel oil by EPA Method 8015 modified and EPA Method 3630A - Silica Gel Cleanup;
- BTEX/MTBE by EPA Method 8015/8021;
- Pesticides and PCBs by EPA Methods 8081 and 8082; and
- Metals (e.g., arsenic, cadmium, chromium, copper, lead, nickel, zinc) (EPA 6000-7000 series).

The goal of the confirmation sampling is to demonstrate removal of soil contamination associated with petroleum-related releases. As described above and discussed in Section 5.4.3, a portion of the soil contamination within the Building 231 RU will be inaccessible for excavation beneath the adjacent/abutting overpass, and historic structures (historic wall; Plate 20b). Therefore, confirmation sampling of excavation bottoms and/or sidewalls in any areas that do not achieve cleanup levels will be conducted to provide a record of potentially remaining contamination.

6.3 Applicable State and Federal Laws and Regulatory Requirements

Implementation of the selected corrective action alternatives will comply with applicable state and federal laws and regulations including the requirements of Title 23, Division 3, Chapter 16, Article 11, which are the primary regulations establishing the requirements and standards for petroleum-related corrective action in the State of California. The alternatives will also comply with applicable laws and regulations regarding management and disposal of excavated soil, including transport to and treatment at regulated and permitted facilities. As detailed in the RWQCB Order, the Building 207/231 CAP Area is a known petroleum contamination site requiring preparation and implementation of this CAP meeting the requirements of 23 CCR § 2725 (2004). The RWQCB Order presents cleanup standards as SCRs for the protection of human health, ecological receptors, and water quality, which have been used to set the applicable CAP cleanup levels. In addition, the Regional Water Quality Control Board, San Francisco Bay Region (RWQCB's) *Transmittal of Final Site Cleanup Requirements for Petroleum Impacted Soils*

(RWQCB, 2003) and the RWQCB Water Quality Control Plan for the San Francisco Bay Region (known as the Basin Plan) pertaining to water quality within the state, have been taken into account in establishing the CAP cleanup levels.

The Presidio as a whole is within the GGNRA and is listed in the National Register of Historic Places as a Historic Landmark, which affords its historic resources and cultural landscapes certain protection under the National Historic Preservation Act (NHPA). The NPS and Trust Programmatic Agreements, which set forth the procedures to implement the historic compliance process of Section 106 of the NHPA, will be followed. In addition, archeological sites and resources are known to exist or may be discovered within the Presidio. Prior to corrective action implementation, the Trust will comply with applicable provisions of the Archeological and Historic Preservation Act (AHPA) and the Native American Graves Protection and Repatriation Act (NAGPRA), and plans to comply with these provisions and minimize adverse impacts to these resources during implementation of corrective action alternatives by (1) conducting a pre-construction archaeological investigation; (2) requiring archaeological monitoring during intrusive activities to prevent adverse impacts; and (3) developing and recommending corrective action alternatives for RUs with identified historic resources that would not adversely affect their integrity (e.g., capping instead of excavation). Other federal and state statutes, such as the federal and state Endangered Species Acts (ESA and CESA), and the Migratory Bird Treaty Act (MBTA), also provide standards for protection of natural resources found on the Presidio that will be followed during this corrective action. The corrective action will be completed in a manner consistent with land uses established by the PTMP, NPS Management Policies, and the Presidio Vegetation Management Plan (*Trust and NPS, 2001*).

With regard to soil excavation and disposal, state laws and regulations implement the federal Resource Conservation and Recovery Act (RCRA) standards and are applicable to the corrective actions at the Building 207/231 CAP Area. These provisions include standards for properly storing, handling, and

transporting excavated soils that may contain hazardous constituents. These regulations also set standards for testing of potential hazardous wastes prior to management and offsite disposal.

The impacted soil at the Building 207/231 CAP Area is not believed to be hazardous waste. The transport and disposal of nonhazardous waste that may be generated during the corrective action will be performed in accordance with the pertinent sections of Title 27 of the California Code of Regulations, which addresses the proper management of solid wastes. The applicability of the Toxic Substance Control Act (TSCA) in regard~~s~~ to the presence of PCBs (e.g., Arochlor 1016) within soil at the Building 231 RU would be assessed if PCBs are detected above 50 mg/kg during soil profiling or confirmation sampling.

The corrective actions at the Building 207/231 CAP Area take into account the RWQCB Basin Plan policy of no loss of wetlands as well as Presidio wetlands resources (*NPS and Trust, 2003*). Any applicable discharge prohibitions and erosion control measures will protect surface water and wetland resources. Also, Bay Area Air Quality Management District (BAAQMD) regulations pertinent to dust suppression and onsite air monitoring during excavation work will be met to prevent air quality impacts from the selected corrective actions. Although not anticipated to be present, if unknown USTs are found during corrective action activities, removal will comply with applicable state and local requirements.

6.4 Archaeological Monitoring

The Site is in proximity to areas known to be archaeologically sensitive. The Trust will comply with applicable provisions of the Archeological and Historic Preservation Act (AHPA), the National Historic Preservation Act (NHPA), the Native American Graves Protection and Repatriation Act (NAGPRA), and minimize adverse impacts to known and potential resources during implementation of corrective action alternatives by (1) conducting a pre-construction archaeological investigation; (2) requiring archaeological monitoring during intrusive activities to prevent adverse impacts; and (3) developing and

recommending corrective action alternatives for RUs with identified historic resources that would not adversely affect their integrity (e.g., capping instead of excavation). Corrective action work will be monitored per the Programmatic Agreement for the Presidio between the Trust and the State Historic Preservation Officer. Work will only be performed following coordination with and approval by Trust and NPS historians and archaeologists. If items of archeologically or historically sensitive importance are found or suspected to be present, field personnel will contact the Trust and NPS immediately.

Through the Trust Project Manager, the corrective action will be coordinated with Trust and NPS naturalists, historians, and archaeologists regarding sensitive areas that may exist at or near the Building 207/231 CAP Area and take appropriate precautions during the field investigation.

6.5 Groundwater Monitoring

Pre-Construction and Post-Construction groundwater monitoring for petroleum-related COCs (and arsenic and associated redox parameters during the first year of monitoring) are included as part of the ~~recommended~~ selected corrective action alternative for each of the RUs as described in Section 5.5. As described in Section 5.5.5, for the Building 230 Soil RU where groundwater has not yet been sampled to assess groundwater impacts and no Groundwater RU has been identified in this CAP, monitoring of a downgradient well and collection of two HydroPunch groundwater confirmation samples within the Soil RU excavation after soil has been removed will be conducted to assess groundwater impacts at this RU.

Water level measurements and field measurements of pH, specific conductance, and dissolved oxygen (DO) will be conducted at each well. In addition, as summarized in Table 7, each well will be sampled and analyzed for the RU-specific COCs identified for each of the Groundwater RUs described in Section 4.4; as well as arsenic and associated redox parameters as follows:

- TPH as gasoline/BTEX/MTBE by EPA Method 8015/8021;
- TPH as diesel and fuel oil by EPA Method 8015 modified with Silica-Gel Cleanup;

- PAHs by EPA Method 8270-SIM;
- Pesticides and PCBs by EPA Methods 8081 and 8082;
- Dissolved arsenic, iron, manganese, and aluminum (EPA Method 6010)
- Field parameters including DO, ORP, specific conductance, and pH.
- ~~Arsenic, Iron, Manganese, Aluminum, and other metals if detected above cleanup levels by EPA Method 6010/7740;~~
- ~~Nitrate, Nitrite, Sulfate by EPA Method 300.0;~~
- ~~Sulfide by EPA Method 376;~~
- ~~Dissolved Gasses (MEE) by RSK-175; and~~
- ~~Total Organic Carbon by EPA Method 415.2.~~

Monitoring Frequency

Pre-Construction Monitoring: Table 7 and Plate 21 indicate the 11 existing~~10~~ wells/piezometers (selected due to prior detections of arsenic) that will be sampled for petroleum-related COCs, arsenic, and associated redox parameters for one event~~ (Summer of 2006)~~ during the first year of monitoring to establish concentration trends.~~;~~

Post-Construction Monitoring:

- Excavation Alternative—Table 7 and Plate 21 indicate the 10~~8~~ wells (4~~3~~ existing and 6~~5~~ newly installed wells) that will be used for downgradient monitoring of each RU to monitor concentrations of COCs in groundwater and the effectiveness of the remedy in achieving cleanup levels after implementation of the corrective action alternative. These wells will be sampled quarterly during Year 1 for petroleum-related COCs, arsenic, and associated redox

parameters and semi-annually thereafter for petroleum-related COCs. After four consecutive monitoring events during which COC concentrations are below cleanup levels, the Post-Construction Monitoring Program will cease, and the appropriate approvals will be ~~g~~obtained from the regulatory agencies for well destruction/abandonment~~.~~ upon regulatory (RWQCB) approval. Well abandonment will be performed in accordance with State of California Water Well Standards and DPH requirements, with the exception of using neat bentonite to backfill the hole because this material would be more compatible with future restoration of the Crissy Marsh than concrete. For the purposes of estimating costs for implementation of the Excavation Alternative, it is assumed that groundwater monitoring will be performed for 3 years (COCs will be below cleanup levels after one year of quarterly monitoring and two more years of semi-annual groundwater monitoring).

- Capping/Land Use Control Alternative—Table 7 and Plate 21 indicate the 10~~8~~ wells (4~~3~~ existing and 6~~5~~ newly installed wells) that will be used for downgradient monitoring of each RU to monitor concentrations of COCs in groundwater and the effectiveness of the remedy in achieving cleanup levels after implementation of the corrective action alternative. For the Building 228 Area RU for which capping, a land use control (LUC), and in situ injection of oxygen release product is the selected alternative, the new downgradient well that will be installed~~These wells~~ will be sampled quarterly during Year 1 for petroleum-related COCs, arsenic, and associated redox parameters to assess the effectiveness of the injection in reducing concentrations of petroleum-related COCs; and semi-annually thereafter for petroleum-related COCs~~, and will be analyzed once during the first year for arsenic and associated redox parameters~~. After 2 consecutive monitoring events during which COCs are below cleanup levels, the Post-Construction Monitoring Program will cease, and the appropriate approvals will be ~~g~~obtained from the regulatory agencies for well destruction/abandonment upon regulatory (RWQCB) approval. Well abandonment will be performed in accordance with State of

California Water Well Standards and DPH requirements, with the exception of using neat bentonite to backfill the hole because this material would be more compatible with future restoration of the Crissy Marsh than concrete. For the purposes of estimating costs for implementation of the Capping/LUC Alternative (for all RUs except Building 228 Area that do not include oxygen release product injection and effectiveness assessment), it is assumed that groundwater monitoring will be performed for 10 years (after 8 years of annual monitoring, COCs will be below cleanup levels during the final two years of annual groundwater monitoring).

The analytical methods, sampling frequency, and duration for the Groundwater Monitoring Program (described in Table 7 and Section 6.5) will be incorporated into the sampling and analytical program for the Presidio-wide Quarterly Groundwater Monitoring Program (*T&R, 2003*).

Cessation of Groundwater Monitoring Program: In the future, the monitoring program (analyses and number of wells sampled) will be adapted as necessary, and monitoring wells will be abandoned as described above pending RWQCB approval~~concurrence~~ when sufficient data have been collected to assess whether COC concentrations in groundwater have been reduced to below cleanup levels. Groundwater monitoring will be revised and/or cease under the following scenarios:

- Cease Monitoring By Analytical Suite: If COCs are below cleanup levels for an entire analytical suite within a given well (e.g., TPH, VOCs, metals), the analytical suite will no longer be included in the monitoring program for that well; or

- Cease Monitoring By Well: If COCs are below cleanup levels for all analytes for a given well, the well will no longer be included in the monitoring program.

Groundwater samples, including QA/QC samples (duplicates, equipment blanks, and trip blanks), will be collected and analyzed at the frequency described above as ~~and~~ summarized in Table 7, and in accordance with the Presidio-wide Quality Assurance Project Plan (*Tetra Tech, 2001*) for the COCs listed above.

A total of 57 wells (51 existing wells and 6 new wells) within the Building 207/231 CAP Area (Table 7 and Plate 21) will eventually be abandoned upon regulatory approval after corrective action monitoring programs cease according to the criteria described above. The following wells will be abandoned during construction and implementation of the selected corrective action alternatives as summarized in Table 7 and shown on Plate 21:

- 40 existing groundwater monitoring wells within the Building 207/231 CAP Area that are not included in Groundwater Monitoring Program required by this CAP, and

- 7 existing groundwater monitoring wells within the Building 207/231 CAP Area that are included only in the Pre-Construction Groundwater Monitoring Program required by this CAP ~~(Table 7 and Plate 21) will be abandoned during construction and implementation of the selected corrective action alternatives~~.

- ~~The~~ 10~~16~~ wells (4 existing and 6 newly installed wells) ~~used in the Pre- and~~ that are included in the Post-Construction Monitoring Program required by this CAP~~(Table 7 and Plate 21) will be abandoned upon regulatory approval after these programs cease according to the criteria described above~~.

In accordance with Task 13 of RWQCB Order R2-2003-0080, a Five-Year Status Report, which evaluates the effectiveness of this CAP for groundwater, will be completed and submitted to the RWQCB for approval. In the Five-Year Status Report, groundwater conditions at the Building 207/231 Area will be evaluated and future corrective actions will be assessed. If cleanup levels for all COCs are achieved within the 5-year monitoring period, the groundwater monitoring program will be discontinued and the

LUC related to groundwater contamination will be rescinded as described above. Once cleanup levels for all COCs are met, the Five Year Review will no longer be required.

6.6 Implementation Schedule

The Trust plans to implement the corrective action alternatives for the five RUs using a phased or concurrent approach depending on RU-specific considerations.

Upon regulatory agency approval of the Final CAP, the CAP Work Plan for the ~~recommended~~ selected alternatives will be submitted no later than 2 months before the start of construction. Start of construction will be contingent upon regulatory (RWQCB) approval of the Building 207/231 CAP Area Implementation Work Plan and is anticipated to occur by November 30, 2007.

As required by the Board Order, a Construction Completion Report documenting implementation of the Building 207/231 CAP Area corrective actions, will be issued after construction is completed (anticipated to be December 31, 2008). The Construction Completion Report will also include at least one round of groundwater monitoring results and the Building 207/231 CAP Area Site-Specific Addendum to the LUCMRR as described in Section 5.1.2.2.

~~As required by the current Board Order, a report documenting implementation of the Building 207/231 CAP Area corrective actions will be issued on or before the start of construction (anticipated to be November 30, 2006), and the Construction Completion Report documenting construction and groundwater monitoring completion results will be issued after construction is completed (anticipated to be December 31, 2007).~~

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TABLES

Table 3. Soil Cleanup Levels
Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco, California

	Compilation of Applicable Cleanup Levels											
	Petroleum-Related [b]		Non Petroleum-Related					Freshwater Protection Zones [g]		Saltwater Protection Zones [h]		
Chemical [a]	Cleanup Level (mg/kg)	Basis for Cleanup Level	Background [c] (mg/kg)	Human Health (Residential) [d] (mg/kg)	Ecological (Buffer Zone) [e] (mg/kg)	Ecological (Special Status) [e] (mg/kg)	RWQCB ESLs [f] (mg/kg)	Sediment Cleanup Level (mg/kg)	Basis for Cleanup Level	Sediment Cleanup Level (mg/kg)	Basis for Cleanup Level	**Lowest Applicable Cleanup Level [i] (mg/kg)**
Total Petroleum Hydrocarbons (TPH)												
TPH as gasoline	100	Water Quality: <5 feet above water table	--	--	--	--	--	140	Freshwater POCC	11.6	Saltwater POCC	**11.6**
TPH as diesel	115	Water Quality: <5 feet above water table	--	--	--	--	--	144	Saltwater POCC	144	Saltwater POCC	**115**
TPH as fuel oil	160	Water Quality: <5 feet above water table	--	--	--	--	--	144	Saltwater POCC	144	Saltwater POCC	**144**
TPH Unknown Diesel Hydrocarbon [j]												
TPH Unknown Gasoline Hydrocarbon [k]												
Polynuclear Aromatic Hydrocarbons (PAHs)												
Acenaphthene	--	--	--	2,700	40	30	--	0.31	Ecological: Freshwater	0.32	Ecological: Marine	**0.31**
Acenaphthylene	--	--	--	--	40	30	--	0.067	Ecological: Freshwater	0.34	Ecological: Marine	**0.067**
Anthracene	308	Water Quality: <5 feet above water table	--	14,000	40	30	--	0.45	Ecological: Freshwater	0.59	Ecological: Marine	**0.45**
Benzo(a)anthracene	0.43	Human health: residential	--	0.27	40	30	--	0.54	Ecological: Freshwater	0.93	Ecological: Marine	**0.27**
Benzo(a)pyrene	0.04	Human health: residential	--	0.027	40	30	--	0.74	Ecological: Freshwater	1.0	Ecological: Marine	**0.027**
Benzo(b)fluoranthene	0.43	Human health: residential	--	0.27	40	30	--	0.79	Ecological: Freshwater	0.79	Ecological: Freshwater	**0.27**
Benzo(b+k)flouranthene, Total	0.43	Human health: residential	--	0.27	40	30	--	0.79	Ecological: Freshwater	0.79	Ecological: Freshwater	**0.27**
Benzo(g,h,i)perylene	620	Human health: residential	--	--	40	30	--	0.25	Ecological: Freshwater	0.25	Ecological: Freshwater	**0.25**
Benzo(k)fluoranthene	0.43	Human health: residential	--	0.27	40	30	--	0.79	Ecological: Freshwater	0.79	Ecological: Freshwater	**0.27**
Chrysene	4.3	Human health: residential	--	2.7	40	30	--	0.67	Ecological: Freshwater	1.6	Ecological: Marine	**0.67**
Dibenzo(a,h)anthracene	--	--	--	0.078	40	30	--	0.071	Ecological: Freshwater	0.16	Ecological: Marine	**0.071**
Fluoranthene	316	Water Quality: <5 feet above water table	--	1,800	40	30	--	1.5	Ecological: Freshwater	2.85	Ecological: Marine	**1.5**
Fluorene	60	Water Quality: <5 feet above water table		1,800	40	30	--	0.28	Ecological: Freshwater	0.28	Ecological: Marine	**0.28**
Indeno(1,2,3-cd)pyrene	--	--	--	0.27	40	30	--	0.26	Ecological: Freshwater	0.26	Ecological: Freshwater	**0.26**
Naphthalene	9	Water Quality: <5 feet above water table	--	910	40	30	--	0.3	Ecological: Freshwater	1.1	Ecological: Marine	**0.3**
Phenanthrene	86	Water Quality: <5 feet above water table	--	--	40	30	--	0.61	Ecological: Freshwater	0.87	Ecological: Marine	**0.61**
Pyrene	241	Water Quality: <5 feet above water table	--	1,400	40	30	--	0.79	Ecological: Freshwater	1.6	Ecological: Marine	**0.79**
Total Carcinogenic PAHs	5.6	Human health: residential	--	--	--	--	--	--	--	--	--	**5.6**
Metals / Inorganics												
Aluminum	--	--	--	76000	--	--	--	--	--	--	--	**76000**
Arsenic	--	--	6.2	0.36	64	10	--	19	Ecological: Freshwater	39	Ecological: Marine	**6.2**
Barium	--	--	180	5,000	500	320	--	3,100	Ecological: Freshwater	3,100	Ecological: Marine	**320**
Beryllium	--	--	0.99	140	10	10	--	7,200	Ecological: Freshwater	7,200	Ecological: Marine	**10**
Cadmium	--	--	0.8	1.7	0.23	0.017	--	1.1	Ecological: Freshwater	1.6	Ecological: Marine	**0.8**
Calcium	--	--	--	--	--	--	--	--	--	--	--	**--**
Chromium	--	--	140	1,200	23	4	--	140	Ecological: Freshwater	140	Ecological: Marine	**140**
Cobalt	--	--	21	4,000	48	20	--	50	Ecological: Freshwater	50	Ecological: Freshwater	**21**
Copper	--	--	49	--	120	30	--	114	Ecological: Freshwater	152	Ecological: Marine	**49**
Cyanide	--	--	--	1,000	13,000	6,300	--	--	--	--	--	**1000**
Iron	--	--	--	23000	--	--	--	--	--	--	--	**23000**
Lead	50	Ecological: Terrestrial 0-3 feet bgs (leaded gas)	7.5	400	300	160	--	82	Ecological: Freshwater	132	Ecological: Marine	**50**
Magnesium	--	--	--	--	--	--	--	--	--	--	--	**--**
Manganese	--	--	--	1800	--	--	--	--	--	--	--	**1800**
Mercury	--	--	0.2	20	1.6	0.4	--	0.62	Ecological: Freshwater	0.43	Ecological: Marine	**0.4**
Nickel	--	--	110	1,400	71	30	--	110	Ecological: Freshwater	110	Ecological: Marine	**110**
Potassium	--	--	--	--	--	--	--	--	--	--	--	**--**
Silver	--	--	1.0	360	2	2	--	1.0	Ecological: Freshwater	2.4	Ecological: Marine	**1**
Sodium	--	--	--	--	--	--	--	--	--	--	--	**--**
Vanadium	--	--	90	650	5	2	--	90	Ecological: Freshwater	90	Ecological: Marine	**90**
Zinc	--	--	60	22,000	50	4	--	230	Ecological: Freshwater	214	Ecological: Marine	**60**
Volatile Organic Compounds (VOCs)												
1,2,4-Trimethylbenzene [l]	--	--	--	52	--	--	--	--	--	--	--	**52**
1,2-Dichlorobenzene [m]	--	--	--	8.9	30	--	1.1	--	--	--	--	**1.1**
1,3,5-Trimethylbenzene [l]	--	--	--	21	--	--	--	--	--	--	--	**21**
1,4-Dichlorobenzene	--	--	--	0.13	74	20	--	0.35	Ecological: Freshwater	0.35	Ecological: Marine	**0.13**
2-Butanone	--	--	--	3.8	15,000	4,200	--	--	--	--	--	**3.8**
2-Hexanone [n]	--	--	--	130	--	--	2.8	--	--	--	--	**2.8**

	Compilation of Applicable Cleanup Levels											
	Petroleum-Related [b]		Non Petroleum-Related					Freshwater Protection Zones [g]		Saltwater Protection Zones [h]		**Lowest Applicable Cleanup Level [i] (mg/kg)**
Chemical [a]	Cleanup Level (mg/kg)	Basis for Cleanup Level	Background [c] (mg/kg)	Human Health (Residential) [d] (mg/kg)	Ecological (Buffer Zone) [e] (mg/kg)	Ecological (Special Status) [e] (mg/kg)	RWQCB ESLs [f] (mg/kg)	Sediment Cleanup Level (mg/kg)	Basis for Cleanup Level	Sediment Cleanup Level (mg/kg)	Basis for Cleanup Level	
Acetone	--	--	--	0.24	68,000	8,500	--	--	--	--	--	**0.24**
Benzene	0.005	Water Quality: <5 feet above water table	--	--	--	--	--	0.79	Freshwater POCC	50	Saltwater POCC	**0.005**
Carbon disulfide	--	--	--	200	14,000	934	--	--	--	--	--	**200**
cis-1,2-Dichloroethene [m]	--	--	--	1.6	--	--	0.19	--	--	--	--	**0.19**
Ethylbenzene	13	Water Quality: <5 feet above water table	--	--	--	--	--	15	Freshwater POCC	5	Saltwater POCC	**5**
Methyl tertiary butyl ether [m]	--	--	--	2.0	--	--	0.023	--	--	190	Saltwater POCC	**0.023**
Methylene chloride	--	--	--	0.076	17,000	459	--	--	--	--	--	**0.076**
Tetrachloroethene [m]	--	--	--	0.088	--	--	0.7	--	--	--	--	**0.088**
Toluene	1	Water Quality: <5 feet above water table	--	--	--	--	--	3	Freshwater POCC	260	Saltwater POCC	**1**
Trichloroethene [m]	--	--	--	0.26	60	--	0.46	--	--	--	--	**0.26**
Xylenes	33	Water Quality: <5 feet above water table	--	--	--	--	--	5.7	Freshwater POCC	22	Saltwater POCC	**5.7**
Xylenes (m&p-)	33	Water Quality: <5 feet above water table	--	--	--	--	--	5.7	Freshwater POCC	22	Saltwater POCC	**5.7**
Xylenes (o-)	33	Water Quality: <5 feet above water table	--	--	--	--	--	5.7	Freshwater POCC	22	Saltwater POCC	**5.7**
Semi-Volatile Organic Compounds (SVOCs)												
Bis(2-ethylhexyl)phthalate [m]	--	--	--	160	--	--	66	--	--	--	--	**66**
Pesticides and PCBs												
4,4-DDD	--	--	--	2.0	0.53	0.049	--	0.016	Ecological: Freshwater	0.011	Ecological: Marine	**0.011**
Arochlor 1016	--	--	--	0.16	0.23	0.033	--	0.36	Ecological: Freshwater	0.10	Ecological: Marine	**0.033**

Notes:

mg/kg	Milligrams per kilogram.
<	Less than.
--	Not available.
POCC	Point-of-compliance concentration.
ESL	Environmental screening level (*RWQCB, 2005*).

Checked: ____________________

Approved: ____________________

Note: Shaded and bold values are lowest applicable cleanup values.

[a] Only chemicals detected in soil at the Building 207/231 Area are listed.

[b] For petroleum-related constituents, the lowest cleanup levels from the Presidio-Wide Cleanup Level Document *EKI, 2002* ; Table 7-6 Revised May, 2006) are presented. These cleanup values were adopted by the RWQCB in Order No. R2-2003-0080, Presidio-wide Site Cleanup Requirements (*RWQCB, 2003*).

[c] Background cleanup values for Colma soil formation from *EKI, 2002* Table 7-2.

[d] For VOCs, the human health (residential) values listed from *EKI, 2002* incorporate groundwater protection concerns from Table 7-2.

[e] From EKI, 2002 Table 7-2.

[f] The RWQCB ESLs are for chemicals that do not have a Presidio-specific cleanup level established. The values listed are from RWQCB, 2005 Table A-1 for "Groundwater Protection (Soil Leaching).

[g] Sediment values were used in selection of cleanup levels for protection of freshwater ecological receptors. Freshwater and saltwater POCC values are from the *Development of Freshwater TPH-diesel and TPH-fuel oil Point of Compliance Concentrations* (*BBL, 2004*) Table 2.1, and the Ecological: Freshwater values are from *EKI, 2002* Table 7-3 buffer zone ecological cleanup levels for Colma formation

[h] Sediment values were used in selection of cleanup levels for protection of saltwater ecological receptors. Saltwater POCC values are from *BBL, 2004* Table 2.1, and the Ecological: Freshwater values are from *EKI, 2002* Table 7-3 and the Ecological: Saltwater values are from *EKI, 2002* Table 7-4 and from the buffer zone ecological cleanup levels for Colma formation

[i] Cleanup levels used for comparison are lowest of Human Health, Ecological (Buffer Zone), Ecological (Special Status), Freshwater Protection Zone Cleanup Levels, and Saltwater Protection Zone Cleanup Levels. Background used if highe

[j] TPH as diesel cleanup level value used.

[k] TPH as gasoline cleanup level value used.

[l] ESLs not available for 1,2,4- and 1,3,5-trimethylbenzene, so United States Environmental Protection Agency Region 9 Preliminary Remediation Goals *USEPA, 2004*) used for cleanup purposes.

[m] ESLs were applied for these chemicals because they do not have a Presidio-specific cleanup level established. ESL values from *RWQCB, 2005* Table A-1.

[n] Chemical 2-hexanone does not have an established cleanup level or ESL, so MIBK was used as a surrogate for 2-hexanone, which was selected based upon similar physical properties and limited toxicity data. ESL values fron *RWQCB, 2005* Table A-1.

Table 4. Groundwater Cleanup Levels
Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco, California

Chemical [a]	Human Health Drinking Water Cleanup Level (µg/L)	Basis for Cleanup Level	Freshwater Toxicity Cleanup Level (µg/L)	Basis for Cleanup Level	Saltwater Toxicity Cleanup Level [d] (µg/L)	Basis for Cleanup Level	**Lowest Applicable Cleanup Levels [e] (µg/L)**
	Compilation of Applicable Cleanup Levels [b,c]						
Total Petroleum Hydrocarbons (TPH)							
TPH as gasoline	770	FPALDR	443	RWQCB Order	1200	RWQCB Order	**443**
TPH as diesel	880	FPALDR	443	RWQCB Order	2200	RWQCB Order	**443**
TPH as fuel oil	1,200	FPALDR	443	RWQCB Order	2200	RWQCB Order	**443**
TPH Unknown Diesel Hydrocarbon [f]							**443**
TPH Unknown Gasoline Hydrocarbon [g]							**443**
Polynuclear Aromatic Compounds (PAHs)							
Acenaphthene	--	--	1,200	CTR	--	--	**1,200**
Acenaphthylene	--	--	--	--	--	--	**--**
Anthracene	770	FPALDR	9,600	CTR	--	--	**770**
Benzo(a)anthracene	0.1	Proposed MCL	0.0044	CTR	--	--	**0.0044**
Benzo(a)pyrene	0.2	Federal MCL	0.0044	CTR	--	--	**0.0044**
Benzo(b)fluoranthene	0.2	Proposed MCL	0.0044	CTR	--	--	**0.0044**
Benzo(k)fluoranthene	2	FPALDR	0.0044	CTR	--	--	**0.0044**
Benzo(b+k)flouranthene, Total	0.2	Proposed MCL	0.0044	CTR	--	--	**0.0044**
Benzo(g,h,i)perylene	--	--	--	--	--	--	**--**
Chrysene	20	FPALDR	0.0044	CTR	--	--	**0.0044**
Fluoranthene	300	FPALDR	300	CTR	--	--	**300**
Fluorene	300	FPALDR	1,300	CTR	--	--	**300**
Indeno(1,2,3-cd)pyrene	--	--	0.0044	CTR	--	--	**0.0044**
Naphthalene	300	FPALDR	--	--	--	--	**300**
Phenanthrene	230	FPALDR	--	--	--	--	**230**
Pyrene	230	FPALDR	960	CTR	--	--	**230**
Total cPAHs	26	FPALDR	0.031	Basin Plan	0.031	Basin Plan	**0.031**
Metals / Inorganics							
Aluminum	1,000	California MCL	--	--	--	--	**1,000**
Arsenic	10	Federal MCL	150	Basin Plan	36	Basin Plan	**10**
Barium	1,000	California MCL	--	--	--	--	**1,000**
Cadmium	5	Federal MCL	1.1	Basin Plan	9.3	Basin Plan	**1.1**
Calcium	--	--	--	--	--	--	**--**
Chloride	250,000	Secondary MCL	--	--	--	--	**250,000**
Chromium	50	California MCL	180	CTR	50	Basin Plan	**50**
Cobalt	140	ESL - Human health	3.0	ESL - Aquatic life	3.0	ESL - Aquatic life	**3**
Copper	1,000	Secondary MCL	9	Basin Plan	3.1	CTR	**3.1**
Iron	--	--	--	--	--	--	**--**
Lead	15	Federal MCL	2.5	Basin Plan	8.1	Basin Plan	**2.5**
Magnesium	--	--	--	--	--	--	**--**
Manganese	--	--	--	--	--	--	**--**
Nickel	100	California MCL	52	Basin Plan	8.2	CTR	**8.2**
Nitrate	10,000	Federal MCL	--	--	--	--	**10,000**
Potassium	--	--	--	--	--	--	**--**
Sodium	--	--	--	--	--	--	**--**

Table 4. Groundwater Cleanup Levels
Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco, California

	Compilation of Applicable Cleanup Levels[b,c]						
Chemical [a]	Human Health Drinking Water Cleanup Level (µg/L)	Basis for Cleanup Level	Freshwater Toxicity Cleanup Level (µg/L)	Basis for Cleanup Level	Saltwater Toxicity Cleanup Level [d] (µg/L)	Basis for Cleanup Level	**Lowest Applicable Cleanup Levels[e] (µg/L)**
Vanadium	15	ESL - Human health	19	ESL - Aquatic life	19	ESL - Aquatic life	**15**
Zinc	5,000	Secondary MCL	120	Basin Plan	81	Basin Plan	**81**
Volatile Organic Compounds (VOCs)							
1,1,1-Trichloroethane	200	Federal MCL	--	--	--	--	**200**
1,1,2,2-Tetrachloroethane	1	California MCL	420	ESL - Aquatic life	420	ESL - Aquatic life	**1**
1,1,2-Trichloroethane	5	California MCL	4700	ESL - Aquatic life	4700	ESL - Aquatic life	**5**
1,1,-Dichloroethane	5	California MCL	47	ESL - Aquatic life	47	ESL - Aquatic life	**5**
1,2,4-Trimethylbenzene	--	--	--	--	--	--	**--**
1,2-Dichlorobenzene	600	California MCL	14	ESL - Aquatic life	14	ESL - Aquatic life	**14**
1,2-Dichloroethane	0.5	California MCL	0.38	CTR	--	--	**0.38**
1,2-Dichloroethene (cis & trans)	6	California MCL	590	ESL - Aquatic life	590	ESL - Aquatic life	**6**
1,2-Dichloropropane	5	California MCL	1500	ESL - Aquatic life	1500	ESL - Aquatic life	**5**
1,3,5-Trimethylbenzene	--	--	--	--	--	--	**--**
1,3-Dichlorobenzene	6.3	ESL - Human health	65	ESL - Aquatic life	65	ESL - Aquatic life	**6.3**
1,4-Dichlorobenzene	5	California MCL	400	CTR	--	--	**5**
2-Butanone	4,200	ESL - Human health	14,000	ESL - Aquatic life	14,000	ESL - Aquatic life	**4,200**
Acetone	6,300	ESL - Human health	1500	ESL - Aquatic life	1500	ESL - Aquatic life	**1,500**
Benzene	1	California MCL	463	RWQCB Order	510	RWQCB Order	**1**
Bromoform	100	California MCL/ESL - Human health	3200	ESL - Aquatic life	3200	ESL - Aquatic life	**100**
Carbon dioxide	--	--	--	--	--	--	**--**
Carbon disulfide	--	--	--	--	--	--	**--**
Chlorobenzene	70	California MCL	680	CTR	--	--	**70**
Chloroform	80	Federal MCL	620	ESL - Aquatic life	620	ESL - Aquatic life	**80**
Chloromethane	1.3	ESL - Human health	3200	ESL - Aquatic life	3200	ESL - Aquatic life	**1.3**
cis-1,2-Dichloroethene	6	California MCL	590	ESL - Aquatic life	590	ESL - Aquatic life	**6**
Ethane	--	--	--	--	--	--	**--**
Ethene	--	--	--	--	--	--	**--**
Ethylbenzene	700/300	Federal MCL	845	RWQCB Order	43	RWQCB Order	**43**
Methane	--	--	--	--	--	--	**--**
Methyl t-butyl ether	13	California MCL	8000	ESL - Aquatic life	4400	RWQCB Order	**13**
Methylene chloride	5	Federal MCL	4.7	CTR	--	--	**4.7**
sec-Butylbenzene	--	--	--	--	--	--	**--**
Styrene	100	California MCL	100	ESL - Aquatic life	100	ESL - Aquatic life	**100**
tert-Butylbenzene	--	--	--	--	--	--	**--**
Tetrachloroethene	5	Federal MCL	0.8	CTR	--	--	**0.8**
Toluene	150	California MCL	490	RWQCB Order	1000	RWQCB Order	**150**
Trichloroethene	5	Federal MCL	2.7	CTR	--	--	**2.7**
Trichlorofluoromethane	150	California MCL	--	--	--	--	**150**
Vinyl chloride	0.5	California MCL	780	ESL - Aquatic life	780	ESL - Aquatic life	**0.5**
Xylenes	1,750	California MCL	318	RWQCB Order	130	RWQCB Order	**130**
Xylenes (m&p-)	1,750	California MCL	318	RWQCB Order	130	RWQCB Order	**130**
Xylenes (o-)	1,750	California MCL	318	RWQCB Order	130	RWQCB Order	**130**

Table 4. Groundwater Cleanup Levels
Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco, California

Chemical [a]	Compilation of Applicable Cleanup Levels [b,c]						**Lowest Applicable Cleanup Levels [e] (µg/L)**
	Human Health Drinking Water Cleanup Level (µg/L)	Basis for Cleanup Level	Freshwater Toxicity Cleanup Level (µg/L)	Basis for Cleanup Level	Saltwater Toxicity Cleanup Level [d] (µg/L)	Basis for Cleanup Level	
Polychlorinated Biphenyls (PCBs)							
Aroclor 1016	0.5	Federal MCL	0.00017	CTR	0.03	CTR	**0.00017**

Notes:

µg/L Micrograms per liter.
-- Not available.
MCL Maximum contaminant level.
CTR California Toxics Rule.
cPAH Carcinogenic polycyclic aromatic hydrocarbons.
ESL Environmental screening level (*RWQCB, 2005*).
FPALDR Fuel Product Action Level Development Report (*MW, 1995c*).

Note: Shaded and bold values are lowest applicable cleanup values.

[a] Only chemicals detected in groundwater at the Building 207/231 Area are listed.

[b] For chemicals for which Presidio-specific cleanup levels have been developed, the cleanup levels were compiled from the Presidio-Wide Cleanup Level Document (*EKI, 2002*; Table 7-6 Revised May, 2006). For human health, these cleanup levels consist of MCLs or risk-based values developed in the FPALDR (*MW, 1995c*). For freshwater or saltwater toxicity, these cleanup levels consist of Basin Plan values (updated with *RWQCB, 2004*: freshwater Table 3-4 and saltwater Table 3-3 from the 4-day average), CTR values, or RWQCB Order values (updated with RWQCB Order R2-2003-0080 [*RWQCB, 2003*]: freshwater Table 7 and saltwater Table 6).

[c] For chemicals for which Presidio-specific cleanup levels have not been developed, the cleanup levels were compiled from ESLs for human health and for freshwater and saltwater toxicity for protection of aquatic life from *RWQCB, 2005* Table F-1a.

[d] Values apply to marine or saltwater environments. See footnote b for source information.

[e] Cleanup levels are lowest of Human Health, Freshwater, and Saltwater Toxicity values.

[f] TPH as diesel cleanup level value used.

[g] TPH as gasoline cleanup level value used.

Checked: ____________________
Approved: ____________________

Table 5. Summary of the Evaluation of Corrective Action Alternatives
Corrective Action Plan Building 207/231 Area
Presidio of San Francisco, California

REMEDIAL UNIT	DESCRIPTION OF REMEDIAL UNIT	REMEDIAL ALTERNATIVES		
		NO ACTION	CAPPING, LAND USE CONTROLS, GROUNDWATER MONITORING	EXCAVATION, OFFSITE DISPOSAL OF SOIL, GROUNDWATER MONITORING
FORMER BUILDING 207 AREA (INCLUDING BUILDLING 208 SUMP)	**Soil and Groundwater** EXTENSIVE TPH, VOCs, PAHs IN SOIL & GROUNDWATER IN AREA OF FORMER SERVICE STATION USTs, FORMER BUILDING 208 SUMP	NOT PROTECTIVE	EFFECTIVE & IMPLEMENTABLE IF CRISSY MARSH EXPANSION DOES NOT OCCUR	**EFFECTIVE & IMPLEMENTABLE FOR CRISSY MARSH OR OTHER REUSES**
FORMER BUILDING 38, 38-A, GARAGE AREA	**Soil and Groundwater** LIMITED TPH, VOCs, PAHs, AND METALS IN SOIL & GROUNDWATER NEAR FORMER BUILDING AND ADJACENT TO RAILROAD SPUR	NOT PROTECTIVE	EFFECTIVE & IMPLEMENTABLE IF CRISSY MARSH EXPANSION DOES NOT OCCUR	**EFFECTIVE & IMPLEMENTABLE FOR CRISSY MARSH OR OTHER REUSES**
EXISTING BUILDING 231 AREA (INCLUDING FORMER BUILDING 271 AREA)	**Soil and Groundwater** EXTENSIVE TPH IN SOIL & GROUNDWATER BENEATH EXISTING BUILDING / SOUTH TO HISTORIC WALL & NORTH TO ENCOMPASS FORMER UST AREA & FORMER BUILDING 271 AREA	NOT PROTECTIVE	EFFECTIVE & IMPLEMENTABLE IF CRISSY MARSH EXPANSION DOES NOT OCCUR	**EFFECTIVE & IMPLEMENTABLE FOR CRISSY MARSH OR OTHER REUSES** **ASSUMING BUILDING DEMOLITION**
EXISTING BUILDING 228 AREA	**Soil and Groundwater** LIMITED TPH IN SOIL SOUTH OF BUILDING 228, AND LIMITED TPH IN SOIL AND GROUNDWATER NORTH OF BUILDING 228	NOT PROTECTIVE	**EFFECTIVE & IMPLEMENTABLE** (NOT IN PLANNED CRISSY MARSH EXPANSION AREA)	NOT IMPLEMENTABLE DUE TO POTENTIAL DAMAGE OF HISTORIC WALL & EXISTING HISTORIC BUILDING DESIGNATED FOR PRESERVATION
EXISTING BUILDING 230 AREA	**Soil Only** LIMITED TPH, VOCs, PAHs IN SOIL EAST OF EXISTING BUILDING ADJACENT TO RAILROAD SPUR	NOT PROTECTIVE	**EFFECTIVE & IMPLEMENTABLE** (NOT IN PLANNED CRISSY MARSH EXPANSION AREA)	**EFFECTIVE & IMPLEMENTABLE**

Table 5. Summary of the Evaluation of Corrective Action Alternatives
Corrective Action Plan Building 207/231 Area
Presidio of San Francisco, California

CORRECTIVE ACTION ALTERNATIVE	EVALUATION CRITERIA							
	EFFECTIVENESS		IMPLEMENTABILITY			RELATIVE COST		
	Site-Specific Applicability	Ability to Achieve RAOs	Constructability	Timeliness	Impacts to Ongoing Operations and Resources	Capital Cost	O&M Cost	Total Cost
ALTERNATIVE 1 NO ACTION	All RUs Takes no action to address COCs above cleanup levels. Would not be applicable for any of the RUs, which contain COCs above cleanup levels that are in contact with the saturated zone and would continue to serve as a potential source of groundwater contamination. In addition, significant portions of these RUs occur beneath buildings and contain volatile compounds. Contaminated soil would not be removed, allowing flammable vapors to potentially migrate into the airspace and utility infrastructures inside the buildings. These vapors may pose a health and safety risk from inhalation by workers/future occupants of the building and from potential ignition sources from equipment and tools used in the building.	All RUs Would not achieve RAOs because it takes no action to (1) address the presence of COCs in soil beneath buildings, which would present a risk to workers/future occupants conducting ongoing and planned operations within the buildings, and (2) address the potential source of contaminants to groundwater. Although the COC concentrations are expected to decrease by natural attenuation over a long period of time, the reduction in concentrations would not be significant, and potential reuses would have to be restricted.	All RUs Would not involve construction or operation of equipment.	All RUs Could be implemented in the shortest timeframe because it takes no action.	All RUs Would have impacts on the ongoing and planned operations within the buildings. Potential hazards from vapors in unremediated soil beneath the buildings would have to be mitigated. Workers could be exposed to contaminated soil and vapors, requiring 40-hour hazardous materials training and mitigation of exposures. Soil vapor abatement measures would need to be implemented to prevent migration of COCs into the buildings. In addition, it would not take advantage of the opportunity to implement a corrective action alternative that will allow for Crissy Marsh expansion, which whenever implemented, would be more difficult to implement and disruptive to restoration operations.	NONE Would not require capital expenditures.	NONE Would not require O&M expenditures.	NONE No associated costs.

COCs = chemicals of concern CULs = cleanup levels LUCs = land use controls O&M = operations and maintenance RAOs = Remedial Action Objectives RU = Remedial Unit

Table 5. Summary of the Evaluation of Corrective Action Alternatives
Corrective Action Plan Building 207/231 Area
Presidio of San Francisco, California

CORRECTIVE ACTION ALTERNATIVE	EVALUATION CRITERIA							
	EFFECTIVENESS		IMPLEMENTABILITY			RELATIVE COST		
	Site-Specific Applicability	Ability to Achieve RAOs	Constructability	Timeliness	Impacts to Ongoing Operations and Resources	Capital Cost	O&M Cost	Total Cost
ALTERNATIVE 2 **CAPPING, LAND USE CONTROLS, GROUNDWATER MONITORING**	Existing Building RUs Would be applicable for soil and groundwater associated with existing buildings and historic structures where Crissy Marsh expansion is not anticipated. The building foundations and adjacent areas would be inspected to determine the need for 'capping improvements' (e.g., sealing the flooring and any conduits to the subsurface, monitoring indoor air quality) to prevent future indoor workers from exposure to volatile COCs that may intrude into the building airspace. Improvements would be implemented as necessary. The cap would be permanently maintained and a permanent LUC would be implemented to prevent alternate reuses (for purposes of costing over a period of 30 years). Groundwater monitoring of downgradient wells would be performed annually for a period of 10 years.	Existing Building RUs Would achieve RAOs to the extent practicable based on planned reuse (preserving existing and historic structures and current reuse) in a cost-effective manner because it would eliminate exposure pathways to COCs above CULs and establish LUCs to prevent alternate reuses. Would significantly reduce risks to workers/future occupants conducting ongoing and planned operations within the buildings. Although it would not include removal or treatment of contaminated soil or groundwater, capping to prevent exposures and reduce surface water infiltration, and natural attenuation would eventually serve to reduce the mass of contaminants in shallow soil that may potentially continue to affect groundwater quality. Capping of Building 228 RU would include a one-time injection of oxygen release product throughout the RU to remediate COCs and mitigate the potential for recontamination of the immediately downgradient Building 231 RU.	Existing Building RUs Would consist of standard construction activities for indoor air sampling, inspecting the integrity of foundations and structures, and improving and maintaining caps over these RUs. The equipment, materials, and labor to conduct these activities are readily available. No special permitting, construction, or maintenance of permanent structures or utilities would be required.	Existing Building RUs Could be implemented within a short timeframe.	Existing Building RUs Would have minimal impacts on the ongoing and planned operations within and outside the buildings because capping improvements on existing foundations and pavement and long-term maintenance could be readily performed. Would not require installation of any permanent equipment that would remain in place. Would prevent impacts to historic resources while maintaining their foundational integrity and eliminating potential exposure pathways to COCs beneath the buildings, and prevent potential impacts to cultural resources because intrusive activities would not be conducted except during installation of downgradient monitoring wells or in situ injection borings.	MODERATE~~LOW~~ Would require moderate~~low~~ capital expenditures for indoor air sampling, surveying the integrity of foundations and structures, and maintaining and/or improving impervious caps over these RUs. Administrative aspects of documenting land use controls due to residual contamination would have low relative costs.	HIGH~~MODERATE~~ Would require high~~moderate~~ O&M expenditures for maintaining the caps and land use controls for a period of 30 years, and annual groundwater monitoring for a period of 10 years.	~~LOW TO~~ MODERATE Would have a ~~low to~~ moderate total cost.

COCs = chemicals of concern CULs = cleanup levels LUCs = land use controls O&M = operations and maintenance RAOs = Remedial Action Objectives RU = Remedial Unit

Table 5. Summary of the Evaluation of Corrective Action Alternatives
Corrective Action Plan Building 207/231 Area
Presidio of San Francisco, California

CORRECTIVE ACTION ALTERNATIVE	EVALUATION CRITERIA							
	EFFECTIVENESS		IMPLEMENTABILITY			RELATIVE COST		
	Site-Specific Applicability	Ability to Achieve RAOs	Constructability	Timeliness	Impacts to Ongoing Operations and Resources	Capital Cost	O&M Cost	Total Cost
ALTERNATIVE 3 **EXCAVATION, OFFSITE DISPOSAL OF SOIL, GROUNDWATER MONITORING**	<u>All RUs</u> Would be applicable for all soil and groundwater RUs except in portions that extend beneath existing buildings or abut historic structures that are designated for preservation. All contaminated soil would be removed to the extent practicable. It is anticipated excavation of contaminated soil would extend into the Bay Mud, allowing for significant source removal. In addition, three different backfill options could be implemented depending on the planned restoration for each area, and groundwater monitoring downgradient of each RU would be conducted to verify source removal and remedy effectiveness.	<u>All RUs</u> Would achieve RAOs because it would entirely remove soil-containing COCs above cleanup levels or to the greatest extent practicable. Implementation would significantly reduce risks to workers/future occupants conducting ongoing and planned operations within the buildings, and would also serve to reduce the mass of contaminants in shallow soil that may potentially continue to affect groundwater quality in both RUs.	<u>All RUs</u> Would consist of standard construction activities for soil excavation, dewatering, soil staging and sampling, and offsite transportation and disposal. The equipment, materials, and labor to conduct these activities are readily available. No special permitting, construction, or maintenance of permanent structures or utilities would be required.	<u>All RUs</u> Could be implemented and completed within a moderate timeframe.	<u>All RUs</u> Would have temporary impacts on the ongoing and planned operations within existing buildings, but would not require installation of any equipment that would remain in place or require monitoring and maintenance. Would minimize impacts to historical structures by only excavating areas that can be accessed. During excavation, workers could be exposed to contaminated soil, requiring they receive 40-hour hazardous materials training. Would have impacts on cultural resources due to extensive intrusive activities, but these could be mitigated through archaeological monitoring. Would have eventual positive impacts on ecological resources by removing contaminated soil and allowing for Crissy Marsh expansion.	MODERATE TO HIGH Would require moderate to high capital expenditures for excavation, confirmation sampling and analysis, and offsite disposal of soil. Administrative aspects of monitoring and documenting temporary land use controls due to residual contamination would have a low relative cost.	LOW Would require low O&M expenditures for groundwater monitoring and maintaining a land use control <u>until cleanup levels are met in groundwater</u>~~f or 3 years~~.	MODERATE TO HIGH Would have a moderate to high total cost.

COCs = chemicals of concern CULs = cleanup levels LUCs = land use controls O&M = operations and maintenance RAOs = Remedial Action Objectives RU = Remedial Unit

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Table 6. Summary of Corrective Action Alternatives Selection
Corrective Action Plan Building 207/231 Area
Presidio of San Francisco, California

FORMER BUILDING 207 AREA (INCLUDING BUILDING 208 SUMP) -- EXTENSIVE TPH, VOCs, PAHs IN SOIL & GROUNDWATER IN AREA OF FORMER SERVICE STATION USTs, FORMER BUILDING 208 SUMP				
REMEDIAL ALTERNATIVE	**MAIN COMPONENTS OF REMEDIAL ALTERNATIVE**	**EVALUATION CRITERIA**		
		EFFECTIVENESS	**IMPLEMENTABILITY**	**RELATIVE COST**
NO ACTION	• No remedial action to address contaminants in soil or groundwater.	• Not effective. Would not address contaminants above cleanup levels that pose potential risk to site workers or ecological receptors, except over an extended period of time as reduction of contaminants occurs.	• Easy to implement from technical and construction perspectives. • Would not be implementable from administrative perspectives due to potential exposures under planned reuses/expansions from contaminants in soil and groundwater (a) during excavation/site work; (b) during reuse by ecological receptors.	• Total Costs: None • Capital Costs: None • O&M Costs: None
CAPPING, LAND USE CONTROLS, GROUNDWATER MONITORING	• Capping to (1) establish impervious barrier over contaminants, (2) minimize surface water intrusion and migration of contaminants into groundwater. • Permanent Land Use Control that prohibits other reuses. • Installation of 3~~2~~ new downgradient wells; Annual groundwater monitoring and reporting to assess nature & extent of contaminants over a period of 10 years.	• Effective if existing reuse does not change and potential Doyle Drive, Crissy Marsh, Tennessee Hollow Riparian Corridor expansion site work is not implemented. • Would mitigate exposures to extent practicable based on existing reuse, but would not remediate or eliminate contaminants for unrestricted future reuse.	• Easy to implement via standard construction practices using readily available resources. • Impacts on site operations during cap construction. • No impacts on historic or cultural resources.	• Total Costs: Moderate~~Low~~ ($214,000~~238,000~~) • Capital Costs: Low to Moderate ($157,000~~112,000~~) (Capping improvements) • O&M Costs: Low ($57~~126~~,000) (Maintaining cap, groundwater monitoring, permanent Land Use Control)
RECOMMENDED CORRECTIVE ACTION ALTERNATIVE				
EXCAVATION, OFFSITE DISPOSAL OF SOIL, GROUNDWATER MONITORING	• Excavation of contaminated soil, which is anticipated to extend into the Bay Mud aquitard. • Restoration of excavated area under one of three potential scenarios to provide flexibility for potential Crissy Marsh/Riparian Corridor expansions: (1) completely backfill excavation to current grade and restore pavement and roadways; (2) leave excavation open with interim drainage system to prevent overflow, with backfill and repaving of roadways only; (3) partially backfill excavation to above water table and stabilize with materials compatible with future restoration. • Offsite disposal of soil. • Installation of 3~~2~~ new downgradient wells; Groundwater monitoring and reporting to verify source removal and assess residual contamination.	• Effective, especially if Doyle Drive, Crissy Marsh, Tennessee Hollow Riparian Corridor expansion site work is implemented. • Would permanently remove contaminants and eliminate exposures in the shortest timeframe and to the greatest degree, allowing for planned reuses.	• High level of effort to implement via standard construction practices using readily available resources. • Impacts on site operations from excavation of large area and existing roadways. • Would require significant archaeological monitoring.	• Total Costs: Moderate to High ($256,000~~317,000~~ to $338,000~~360,000~~ for range of backfill options) • Capital Costs: Moderate to High ($250,000~~253,000~~ to $332,000~~296,000~~ for range of backfill options) (Excavation, dewatering, backfilling, restoration, offsite disposal of soil) • O&M Costs: Low ($6~~64~~,000) (Groundwater monitoring, Land Use Control)

FORMER BUILDING 38, 38-A, GARAGE AREA -- LIMITED TPH, VOCs, PAHs AND METALS IN SOIL & GROUNDWATER NEAR FORMER BUILDING AND ADJACENT TO RAILROAD SPUR				
REMEDIAL ALTERNATIVE	**MAIN COMPONENTS OF REMEDIAL ALTERNATIVE**	**EVALUATION CRITERIA**		
		EFFECTIVENESS	**IMPLEMENTABILITY**	**RELATIVE COST**
NO ACTION	• No remedial action to address contaminants in soil or groundwater.	• Not effective. Would not address contaminants above cleanup levels that pose potential risk to site workers or ecological receptors, except over an extended period of time as reduction of contaminants occurs.	• Easy to implement from technical and construction perspectives. • Would not be implementable from administrative perspectives due to potential exposures under planned reuses/expansions from contaminants in soil and groundwater (a) during excavation/site work; (b) during reuse by ecological receptors.	• Total Costs: None • Capital Costs: None • O&M Costs: None
CAPPING, LAND USE CONTROLS, GROUNDWATER MONITORING	• Capping to (1) establish impervious barrier over contaminants, (2) minimize surface water intrusion and migration of contaminants into groundwater. • Permanent Land Use Control that prohibits other reuses. • Installation of 1 new downgradient well; Annual groundwater monitoring and reporting to assess nature & extent of contaminants over a period of 10 years.	• Effective if existing reuse does not change and Crissy Marsh or Tennessee Hollow Riparian Corridor expansion site work is not implemented. • Would mitigate exposures to extent practicable based on existing reuse, but would not remediate or eliminate contaminants for unrestricted future reuse.	• Easy to implement via standard construction practices using readily available resources. • Impacts on site operations during cap construction. • No impacts on historic or cultural resources.	• Total Costs: ~~Low~~Moderate ($161,000~~188,000~~) • Capital Costs: ~~Low~~ Moderate ($104,000~~72,000~~) (Capping improvements) • O&M Costs: Low ($57~~116~~,000) (Maintaining cap, groundwater monitoring, permanent Land Use Control)
RECOMMENDED CORRECTIVE ACTION ALTERNATIVE				
EXCAVATION, OFFSITE DISPOSAL OF SOIL, GROUNDWATER MONITORING	• Excavation of contaminated soil, which is anticipated to extend into the Bay Mud aquitard. • Restoration of excavated area under one of three potential scenarios to provide flexibility for potential Crissy Marsh/Riparian Corridor expansions: (1) completely backfill excavation to current grade and restore pavement and roadways; (2) leave excavation open with interim drainage system to prevent overflow, with backfill and repaving of roadways only; (3) partially backfill excavation to above water table and stabilize with materials compatible with future restoration. • Offsite disposal of soil. • Installation of 1 new downgradient well; Groundwater monitoring and reporting to verify source removal and assess residual contamination.	• Effective, especially if Crissy Marsh or Tennessee Hollow Riparian Corridor expansion site work is implemented. • Would permanently remove contaminants and eliminate exposures in the shortest timeframe and to the greatest degree, allowing for planned reuses.	• High level of effort to implement via standard construction practices using readily available resources. • Areal extent of contamination not well defined; excavation could expand along railroad track areas, thus increasing scope of work and costs. • Would require archaeological monitoring.	• Total Costs: Moderate ~~to High~~ ($191,000~~243,000~~ to $208,000~~249,000~~ for range of backfill options) • Capital Costs: Moderate~~High~~ ($185,000~~186,000~~ to $202,000~~193,000~~ for range of backfill options) (Excavation, dewatering, backfilling, restoration, offsite disposal of soil) • O&M Costs: Low ($6~~57~~,000) (Groundwater monitoring, Land Use Control)

EXISTING BUILDING 231 AREA (INCLUDING FORMER BUILDING 271 AREA) -- EXTENSIVE TPH, VOCs IN SOIL & GROUNDWATER BENEATH EXISTING BUILDING / SOUTH TO HISTORIC WALL & NORTH TO ENCOMPASS FORMER UST AREA & FORMER BUILDING 271 GARAGE AREA

REMEDIAL ALTERNATIVE	MAIN COMPONENTS OF REMEDIAL ALTERNATIVE	EVALUATION CRITERIA		
		EFFECTIVENESS	IMPLEMENTABILITY	RELATIVE COST
NO ACTION	• No remedial action to address contaminants in soil or groundwater.	• Not effective. Would not address contaminants above cleanup levels that pose potential risk to site workers, occupants, or ecological receptors, except over an extended period of time as reduction of contaminants occurs.	• Easy to implement from technical and construction perspectives. • Would not be implementable from administrative perspectives due to potential exposures (1) under existing reuse from contaminant vapors entering occupied building; (2) under planned reuses/expansions from contaminants in soil and groundwater (a) during excavation/site work; (b) during reuse by ecological receptors.	• Total Costs: None • Capital Costs: None • O&M Costs: None
CAPPING, LAND USE CONTROLS, GROUNDWATER MONITORING	• Capping improvements within building foundation and adjacent areas to (1) establish impervious barrier over contaminants, (2) minimize surface water intrusion and migration of contaminants into groundwater. • Permanent Land Use Control that prohibits other reuses. • Installation of 1 new downgradient well; Annual groundwater monitoring and reporting (of 1 new and 3~~1~~ existing wells) to assess nature & extent of contaminants over a period of 10 years.	• Effective if existing reuse does not change and potential Doyle Drive, Crissy Marsh, Tennessee Hollow Riparian Corridor expansion site work is not implemented. • Would mitigate exposures to extent practicable based on existing reuse, but would not remediate or eliminate contaminants for unrestricted future reuse.	• Easy to implement via standard construction practices using readily available resources. • Minimal impacts on site operations. • No impacts on historic wall or cultural resources.	• Total Costs: Moderate~~Low~~ ($898,000~~697,000~~) • Capital Costs: Moderate~~Low~~ ($611,000~~398,000~~) (Capping improvements) • O&M Costs: Moderate~~Low~~ ($287~~299~~,000) (Maintaining cap, groundwater monitoring, permanent Land Use Control)

EXISTING BUILDING 231 AREA (INCLUDING FORMER BUILDING 271 AREA) -- EXTENSIVE TPH, VOCs IN SOIL & GROUNDWATER BENEATH EXISTING BUILDING / SOUTH TO HISTORIC WALL & NORTH TO ENCOMPASS FORMER UST AREA & FORMER BUILDING 271 GARAGE AREA				
RECOMMENDED CORRECTIVE ACTION ALTERNATIVE				
EXCAVATION, OFFSITE DISPOSAL OF SOIL, GROUNDWATER MONITORING	• Demolition of Building 231 and 6 existing monitoring wells located within excavation area. • Excavation of contaminated soil, which is anticipated to extend into the Bay Mud aquitard. • Restoration of excavated area under one of three potential scenarios to provide flexibility for potential Crissy Marsh/Riparian Corridor expansions: (1) completely backfill excavation to current grade and restore pavement and roadways; (2) leave excavation open with interim drainage system to prevent overflow, with backfill and repaving of roadways only; (3) partially backfill excavation to above water table and stabilize with materials compatible with future restoration; install semi-permanent drainage system. • Offsite disposal of soil. • Installation of 1 new downgradient well; Groundwater monitoring and reporting (of 1~~one~~ new well and 3~~one~~ existing wells) to verify source removal and assess residual contamination.	• Effective, especially if Doyle Drive, Crissy Marsh, Tennessee Hollow Riparian Corridor expansion site work is implemented. • Would permanently remove contaminants and eliminate exposures in the shortest timeframe and to the greatest degree, allowing for planned reuses.	• High level of effort to implement via standard construction practices using readily available resources. • Impacts on site operations from building demolition, excavation of large area, and existing roadways. • Would require specialized structural stabilization techniques near historic wall to prevent impacts on historic resources. • Would require significant archaeological monitoring.	• Total Costs: Moderate to High ($1,604,000~~1,516,000~~ to $1,847,000~~1,742,000~~ for range of backfill options) • Capital Costs: Moderate to High ($1,559,000~~1,417,000~~ to $1,802,000~~1,643,000~~ for range of backfill options) (Excavation, dewatering, backfilling, restoration, offsite disposal of soil) • O&M Costs: Low ($45~~99~~,000) (Groundwater monitoring, Land Use Control)

EXISTING BUILDING 228 AREA -- LIMITED TPH IN SOIL SOUTH OF BUILDING 228, AND LIMITED TPH IN SOIL AND GROUNDWATER NORTH OF BUILDING 228				
REMEDIAL ALTERNATIVE	**MAIN COMPONENTS OF REMEDIAL ALTERNATIVE**	**EVALUATION CRITERIA**		
		EFFECTIVENESS	**IMPLEMENTABILITY**	**RELATIVE COST**
NO ACTION	• No remedial action to address contaminants in soil or groundwater.	• Not effective. Would not address contaminants above cleanup levels that pose potential risk to site workers, except over an extended period of time as reduction of contaminants occurs.	• Easy to implement from technical and construction perspectives. • Would not be implementable from administrative perspectives due to potential exposures under existing reuses from contaminants in soil and groundwater.	• Total Costs: None • Capital Costs: None • O&M Costs: None
RECOMMENDED CORRECTIVE ACTION ALTERNATIVE				
CAPPING, LAND USE CONTROLS, IN SITU INJECTION OF OXYGEN RELEASE PRODUCT, GROUNDWATER MONITORING	• Capping improvements within building and extend outside building paved areas to (1) establish impervious barrier over contaminants, (2) minimize surface water intrusion and migration of contaminants into groundwater. • Permanent Land Use Control that prohibits other reuses. • One-time direct push technology in situ injection of oxygen release product within RU (outside building) to remediate contaminants in soil and groundwater directly upgradient of Building 231 RU. • Installation of 1 new downgradient well; Annual groundwater monitoring and reporting to assess nature & extent of contaminants over a period of 10 years. • In Situ Confirmation Sampling 2 years after oxygen release product injection to assess residual contamination.	• Effective for existing reuse consistent with preservation of historic building and wall. • Would mitigate exposures to extent practicable based on existing reuse using cap and land use controls, and would remediate contaminants using in situ oxygen release product injection directly upgradient of Building 231 RU to mitigate potential recontamination. • Would eliminate exposures and remediate contaminants over several years with limited disturbance of existing reuse while preserving historic building and wall. Effectiveness of in situ injection is variable based on the nature and depth of contamination.	• Easy to implement via standard construction practices using readily available resources. • Minimal impacts on site operations. • No impacts on historic wall, historic building.	• Total Costs: Low ($185,000~~241,000~~) • Capital Costs: Low ($118~~126~~,000) (Capping improvements, one-time in situ injection of oxygen release product) • O&M Costs: Low ($67,000~~115,000~~) (Maintaining cap, permanent Land Use Control, Groundwater monitoring)

EXISTING BUILDING 230 AREA -- LIMITED TPH, VOCs, PAHs IN SOIL EAST OF EXISTING BUILDING ADJACENT TO RAILROAD SPUR				
REMEDIAL ALTERNATIVE	**MAIN COMPONENTS OF REMEDIAL ALTERNATIVE**	**EVALUATION CRITERIA**		
		EFFECTIVENESS	**IMPLEMENTABILITY**	**RELATIVE COST**
NO ACTION	• No remedial action to address contaminants in soil or groundwater.	• Not effective. Would not address contaminants above cleanup levels that pose potential risk to site workers, except over an extended period of time as reduction of contaminants occurs.	• Easy to implement from technical and construction perspectives. • Would not be implementable from administrative perspectives due to potential exposures under existing reuses from contaminants in soil and groundwater.	• Total Costs: None • Capital Costs: None • O&M Costs: None
CAPPING, LAND USE CONTROLS	• Capping improvements between existing building and adjacent railroad spur to (1) establish impervious barrier over contaminants, (2) minimize surface water intrusion and migration of contaminants into groundwater. • Installation of 1 new downgradient well; Annual groundwater monitoring and reporting to assess nature & extent of contaminants over a period of 10 years. • Permanent Land Use Control that prohibits other reuses. • Annual groundwater monitoring and reporting of ~~one~~ 1 new~~existing~~ well to assess nature & extent of contaminants over a period of 10 years.	• Effective for existing reuse consistent with continued occupation of building and use of railroad spur. • Would mitigate exposures to extent practicable based on existing reuse while preserving building and railroad spur, but would not remediate or eliminate contaminants for unrestricted future reuse.	• Easy to implement via standard construction practices using readily available resources. • Minimal impacts on site operations. • No impacts on existing building or cultural resources.	• Total Costs: Moderate ($200,000~~189,000~~) • Capital Costs: Low to Moderate ($143~~73~~,000) (Capping improvements) • O&M Costs: High ($57,000~~116,000~~) (Maintaining cap, permanent Land Use Control, groundwater monitoring)
RECOMMENDED CORRECTIVE ACTION ALTERNATIVE				
EXCAVATION, OFFSITE DISPOSAL OF SOIL	• Excavation of contaminated soil, which is anticipated to extend into the Bay Mud aquitard. • Backfill excavation to current grade and restore pavement (Backfill Option C only; area not planned for Crissy Marsh expansion). • Offsite disposal of soil. • Installation of 1 new downgradient well; Groundwater monitoring and reporting of 1 new~~one existing~~ well to verify source removal and assess residual contamination over a period of 3~~10~~ years.	• Effective, especially if Doyle Drive, Crissy Marsh, Tennessee Hollow Riparian Corridor expansion site work is implemented. • Would permanently remove contaminants and eliminate exposures in the shortest timeframe and to the greatest degree.	• High level of effort to implement via specialized construction practices (excavating adjacent to an existing building) using readily available resources. • Impacts on site operations from excavation. • Area extent of excavation not well defined; could expand to areas along railroad tracks or near building.	• Total Costs: Moderate ($228,000~~210,000~~) • Capital Costs: Moderate ($222,000~~154,000~~ for Backfill Option C) (Excavation, dewatering, backfilling, restoration, offsite disposal of soil) • O&M Costs: Low ($6~~56~~,000) (Groundwater monitoring)

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Table 7. Summary of Groundwater Monitoring and Well Abandonment Program
Corrective Action Plan Building 207/231 Area
Presidio of San Francisco, California

Well Name	Water Bearing Zone	Location With Respect to Remedial Units	Perform Well Abandonment During Construction	PRE-CONSTRUCTION MONITORING PROGRAM [3] Frequency and Duration: One-time sampling event at least 2 months prior to start of construction Analytes: TPHd/fo (EPA Method 8015); VOCs (EPA Method 8260); As, Al, Mn, Fe (EPA Method 6010) Field Analysis: Water levels, pH, specific conductance, dissolved oxygen (DO), Redox Parameters	POST-CONSTRUCTION MONITORING PROGRAM [4] Frequency: Excavation Alternative (RUs 207, 38, 231, 230) YEAR 1: Quarterly AFTER YEAR 1: Arsenic and Redox Parameters Annually and all other analytes Semi-Annually Capping Alternative (RU 228) YEAR 1: Quarterly YEAR 2: Arsenic and Redox Parameters Annually and all other analytes Semi-Annually YEARS 3--10: Annually Duration: Monitor Arsenic and Redox Parameters until Arsenic concentrations are below cleanup levels. Monitor all other analytes until COCs are below cleanup levels for 4 consecutive monitoring events. Monitoring will cease on a per individual analyte suite (e.g., VOCs) and /or by well basis Analytes: See RU-specific list of analytes below Field Analysis: Water levels, pH, specific conductance, Redox Parameters
BUILDING 207 AREA REMEDIAL UNIT					
207GW03	INTERMEDIATE	downgradient of RU 207	X		--
New Well 6	SHALLOW	east/crossgradient of RU 207	RETAIN		TPHg (EPA Method 8015) Benzene, MTBE (EPA Method 8021) PAHs (EPA Method 8270-SIM) Nickel (EPA Method 6010)
New Well 3	SHALLOW	downgradient of RU 207	RETAIN		TPHg (EPA Method 8015) Benzene, MTBE (EPA Method 8021) PAHs (EPA Method 8270-SIM) Nickel (EPA Method 6010)
New Well 4	SHALLOW	downgradient of RU 207	RETAIN		TPHg (EPA Method 8015) Benzene, MTBE (EPA Method 8021) PAHs (EPA Method 8270-SIM) Nickel (EPA Method 6010)
BUILDING 231 AREA REMEDIAL UNIT					
New Well 2	SHALLOW	downgradient of RU 231	RETAIN		TPHg (EPA Method 8015) TPHd,fo (EPA Method 8015 w/SGCU) VOCs [BTEX, MeCl, PCE, VC] (EPA Method 8260) PAHs (EPA Method 8270-SIM) Cr, Co, Cu, Pb, Hg, Ni, Ag, Zn (EPA Method 6010)
231GW06	INTERMEDIATE	downgradient of RU 231	X		
231GW09	SHALLOW	upgradient of RUs	RETAIN	X	TPHg (EPA Method 8015) TPHd,fo (EPA Method 8015 w/SGCU) VOCs [BTEX, MeCl, PCE, VC] (EPA Method 8260) PAHs (EPA Method 8270-SIM) Cr, Co, Cu, Pb, Hg, Ni, Ag, Zn, As (EPA Method 6010) Redox Parameters
231GW10	SHALLOW	upgradient of RU 208 sump	X	X	
231GW13	DEEP	west/cross-gradient of RU 207	X		
231GW15	INTERMEDIATE	west/cross-gradient of RU 207	X		
231GW16	SHALLOW	west/cross-gradient of RU 207	RETAIN	X	TPHg (EPA Method 8015) TPHd,fo (EPA Method 8015 w/SGCU) VOCs [BTEX, MeCl, PCE, VC] (EPA Method 8260) PAHs (EPA Method 8270-SIM) Cr, Co, Cu, Pb, Hg, Ni, Ag, Zn, As (EPA Method 6010) Redox Parameters
231GW17	DEEP	west/cross-gradient of RUs	X		
231GW18	INTERMEDIATE	west/cross-gradient of RUs	X		
231GW19	SHALLOW	west/cross-gradient of RUs	X		
231GW20	INTERMEDIATE	downgradient of RU 231	X	X	
231GW21	SHALLOW	downgradient of RU 231	X	X	
231GW22	SHALLOW	downgradient of RU 231	X	X	
231GW23	SHALLOW	upgradient of RUs 207/38	X		
231GW24	SHALLOW	west/cross-gradient of RUs	X		
231GW25	SHALLOW	downgradient of RU 231	RETAIN	X	TPHg (EPA Method 8015) TPHd,fo (EPA Method 8015 w/SGCU) VOCs [BTEX, MeCl, PCE, VC] (EPA Method 8260) PAHs (EPA Method 8270-SIM) Cr, Co, Cu, Pb, Hg, Ni, Ag, Zn, As (EPA Method 6010) Redox Parameters
231GW26	INTERMEDIATE	downgradient of RU 231	X	X	
231GW27	INTERMEDIATE	west/cross-gradient of RUs	X		
231GW28	INTERMEDIATE	east/upgradient of RU 231	X		
231GW29	INTERMEDIATE	west/cross-gradient to RU 230	X		
231GW30	SHALLOW	upgradient of RU 207	X		
231PZ01	SHALLOW	downgradient of RU 231	X	X	
231PZ02	SHALLOW	downgradient of RU 231	X		
231PZ03	SHALLOW	west/cross-gradient to RU 230	X		
231PZ04	SHALLOW	west/cross-gradient to RU 230	X	X	
OW-1	INTERMEDIATE	west/cross-gradient to RU 230	X		
HGB-2-20	--	west/cross-gradient to RU 38	X		
HGB-2-40	--	west/cross-gradient to RU 38	X		
HGB-2-71	--	west/cross-gradient to RU 38	X		
HGB-3-28	--	west/cross-gradient to RU 230	X		
HGB-3-64	--	west/cross-gradient to RU 230	X		
HGB-3-74	--	west/cross-gradient to RU 230	X		
231EW01	--	downgradient of RU 231	X		
231EW02	--	downgradient of RU 231	X		
231EW03	--	downgradient of RU 231	X		
231EW04	--	downgradient of RU 231	X		
231EW05	--	downgradient of RU 231	X		
231EW06	--	downgradient of RU 231	X		
231EW07	--	downgradient of RU 231	X		
231IW01	--	downgradient of RU 231	X		
231IW02	--	downgradient of RU 231	X		
231IW03	--	downgradient of RU 231	X		
231IW04	--	downgradient of RU 231	X		
231IW05	--	downgradient of RU 231	X		
231IW06	--	downgradient of RU 231	X		
231IW07	--	downgradient of RU 231	X		
231IW08	--	downgradient of RU 231	X		
231IW09	--	downgradient of RU 231	X		
231IW10	--	downgradient of RU 231	X		
231IW11	--	downgradient of RU 231	X		

Well Name	Water Bearing Zone	Location With Respect to Remedial Units	Perform Well Abandonment During Construction	PRE-CONSTRUCTION MONITORING PROGRAM [3] Frequency and Duration: One-time sampling event at least 2 months prior to start of construction Analytes: TPHd/fo (EPA Method 8015); VOCs (EPA Method 8260); As, Al, Mn, Fe (EPA Method 6010) Field Analysis: Water levels, pH, specific conductance, dissolved oxygen (DO), Redox Parameters	POST-CONSTRUCTION MONITORING PROGRAM [4] Frequency: Excavation Alternative (RUs 207, 38, 231, 230) YEAR 1: Quarterly AFTER YEAR 1: Arsenic and Redox Parameters Annually and all other analytes Semi-Annually Capping Alternative (RU 228) YEAR 1: Quarterly YEAR 2: Arsenic and Redox Parameters Annually and all other analytes Semi-Annually YEARS 3--10: Annually Duration: Monitor Arsenic and Redox Parameters until Arsenic concentrations are below cleanup levels. Monitor all other analytes until COCs are below cleanup levels for 4 consecutive monitoring events. Monitoring will cease on a per individual analyte suite (e.g., VOCs) and /or by well basis Analytes: See RU-specific list of analytes below Field Analysis: Water levels, pH, specific conductance, Redox Parameters
BUILDING 228 AREA REMEDIAL UNIT					
New Well 1	SHALLOW	downgradient of RU 228	RETAIN		TPHd, TPHfo (EPA Method 8015) VOCs [1,2-DCB] (EPA Method 8260) Nickel (EPA Method 6010)
BUILDING 38 AREA REMEDIAL UNIT					
New Well 5	SHALLOW	downgradient of RU 38	RETAIN		TPHd,fo (EPA Method 8015 w/SGCU) PAHs (EPA Method 8270-SIM) Lead, Zinc (EPA Method 6010)
BUILDING 230 AREA REMEDIAL UNIT					
231GW11	SHALLOW	downgradient of RU 230	RETAIN	X	Soil COCs for which groundwater will be monitored [3]: TPHd,fo (EPA Method 8015 w/SGCU) PAHs (EPA Method 8270-SIM) Lead, Zinc, As (EPA Method 6010) Redox Parameters

FOOTNOTES:
START OF CONSTRUCTION WILL BE CONTINGENT UPON REGULATORY (RWQCB) APPROVAL OF THE BUILDING 207/231 CAP AREA IMPLEMENTATION WORK PLAN.
-- = INDICATES DATA IS NOT APPLICABLE OR AVAILABLE.
[1] ALL POST-CONSTRUCTION MONITORING WELLS WILL BE ABANDONED AFTER MONITORING PROGRAM CRITERIA ARE MET UPON REGULATORY APPROVAL.
[2] NO GROUNDWATER SAMPLING WAS CONDUCTED AT BUILDING 230 RU, THEREFORE COCs IN GROUNDWATER NOT IDENTFIED; ANALYZE FOR SOIL COCs.
[3] PRE-CONSTRUCTION MONITORING OBJECTIVES: ONE TIME MONITORING EVENT TO FURTHER ESTABLISH PRE-CONSTRUCTION BASELINE CONDITIONS FOR (1) PETROLEUM-RELATED COC CONCENTRATION TRENDS, AND (2) ARSENIC AND ASSOCIATED REDOX PARAMETERS.
[4] POST-CONSTRUCTION MONITORING OBJECTIVES: CONDUCT POST-CONSTRUCTION ASSESSMENT OF (1) REMEDY EFFECTIVENESS IN REDUCING COC CONCENTRATIONS BELOW CLEANUP LEVELS, AND (2) POTENTIAL FOR OBTAINING CLEAN CLOSURE OF RU / LISTING OF LAND USE CONTROL IF / WHEN CLEANUP LEVELS ARE MET IN GROUNDWATER AS FOLLOWS.
YEAR 1: MONITOR FOR (1) ARSENIC AND ASSOCIATED REDOX PARAMETERS, AND (2) RU-SPECIFIC COCs.
AFTER YEAR 1: MONITOR FOR (1) ARSENIC AND ASSOCIATED REDOX PARAMETERS ANNUALLY (2) RU-SPECIFIC COCs SEMI-ANNUALLY.
"REDOX PARAMETERS" ARE OTHER METALS ANALYZED UNDER EPA TEST METHOD 6010 WITH As (Al, Fe, Mn) AND FIELD MEASUREMENT OF DISSOLVED OXYGEN (DO) AND OXIDATION REDUCTION POTENTIAL (ORP)

PLATES

EXPLANATION

- BUILDING 207/231 AREA (SITE)
- TENNESSEE HOLLOW FRESH WATER ECOLOGICAL PROTECTION ZONE
- CRISSY FIELD SALTWATER PROTECTION ZONE
- AREA A / AREA B BOUNDARY

Notes

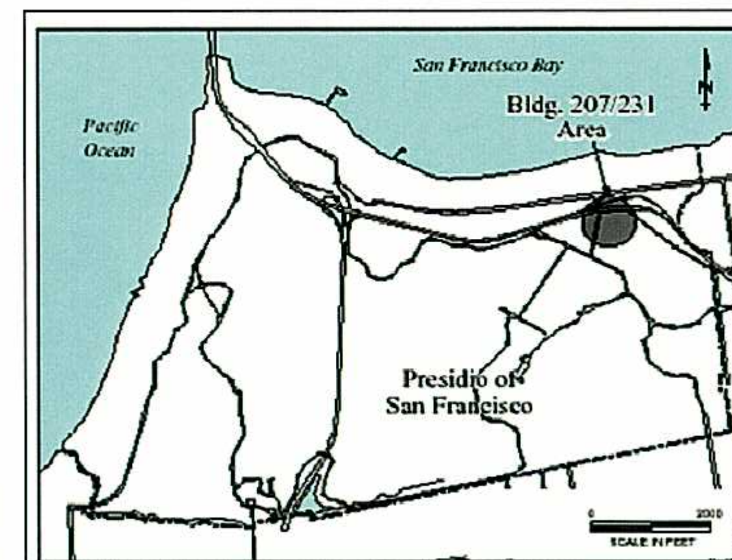
1. Area A consists of the Crissy Marsh to the north and is under the stewardship of the National Parks Sevice.

2. Area B consists of the developed area southwest of the line and is under the stewardship of the Presidio Trust.

N

0 200 400

SCALE IN FEET



4089041001069.DWG 1.0
20060725.1412

NOTE:
AERIAL PHOTOGRAPHY DATA MARCH 24, 2000
SOURCE: PRESIDIO TRUST GIS DEPARTMENT

MACTEC

Site Location Map
Corrective Action Plan
Building 207/231
Presidio of San Francisco
San Francisco, California

PLATE

1

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
PH	4089041001 106				

EXPLANATION

FORMER RAILROAD TRACKS

202 FORMER STRUCTURE OR FEATURE

BUILDING 207/231 AREA

SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)

FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH OF BLUE LINE)

STAINED AREA

FORMER EXCAVATION

0 80 160

SCALE IN FEET

MACTEC

Site Plan
Corrective Action Plan
Building 207/231
Presidio of San Francisco
San Francisco, California

PLATE

2

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
CN	4089041001 106				

EXPLANATION

PREHISTORIC SITES

1871 CONTOURS (FEET, MEAN SEA LEVEL)

TG8 DOYLE STUDY SAMPLE ARCHAEOLOGICAL TRENCH

#67 ARCHAEOLOGICAL CORE LOCATIONS

BUILDING 207/231 AREA SITE

TENNESSEE HOLLOW FRESH WATER ECOLOGICAL PROTECTION ZONE

CRISSY FIELD SALTWATER PROTECTION ZONE

CURRENT SUBSURFACE PIPE FOR TENNESSEE HOLLOW

NOTE: AERIAL PHOTOGRAPHY DATA MARCH 24, 2000 SOURCE: PRESIDIO TRUST GIS DEPARTMENT.

4089041001025.DWG 1.0
20060707.0858

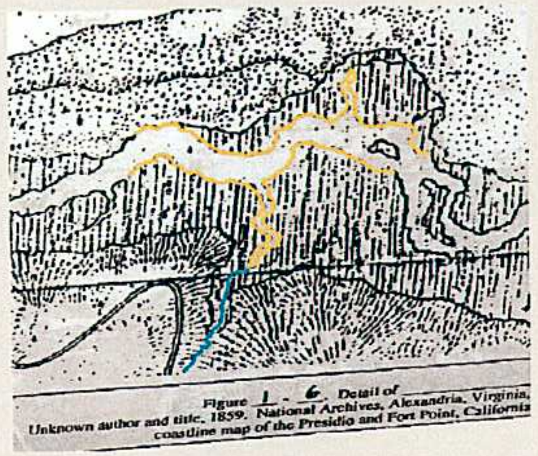
MACTEC

Natural and Cultural Resources
Corrective Action Plan
Building 207/231
Presidio of San Francisco
San Francisco, California

PLATE
3a

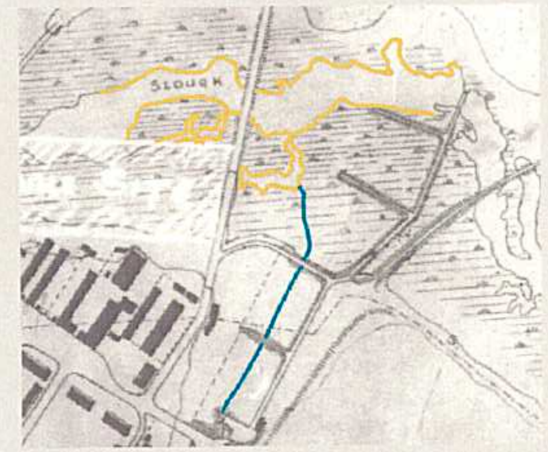
DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
PH	4089041001 106				

1859



1888

1893



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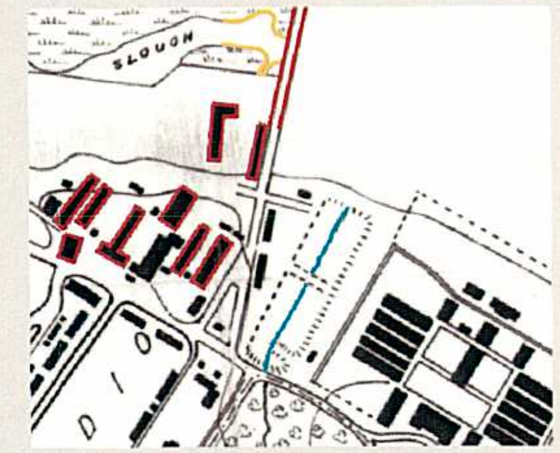

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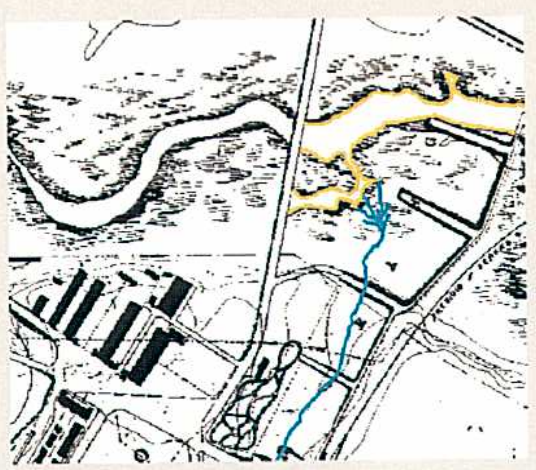
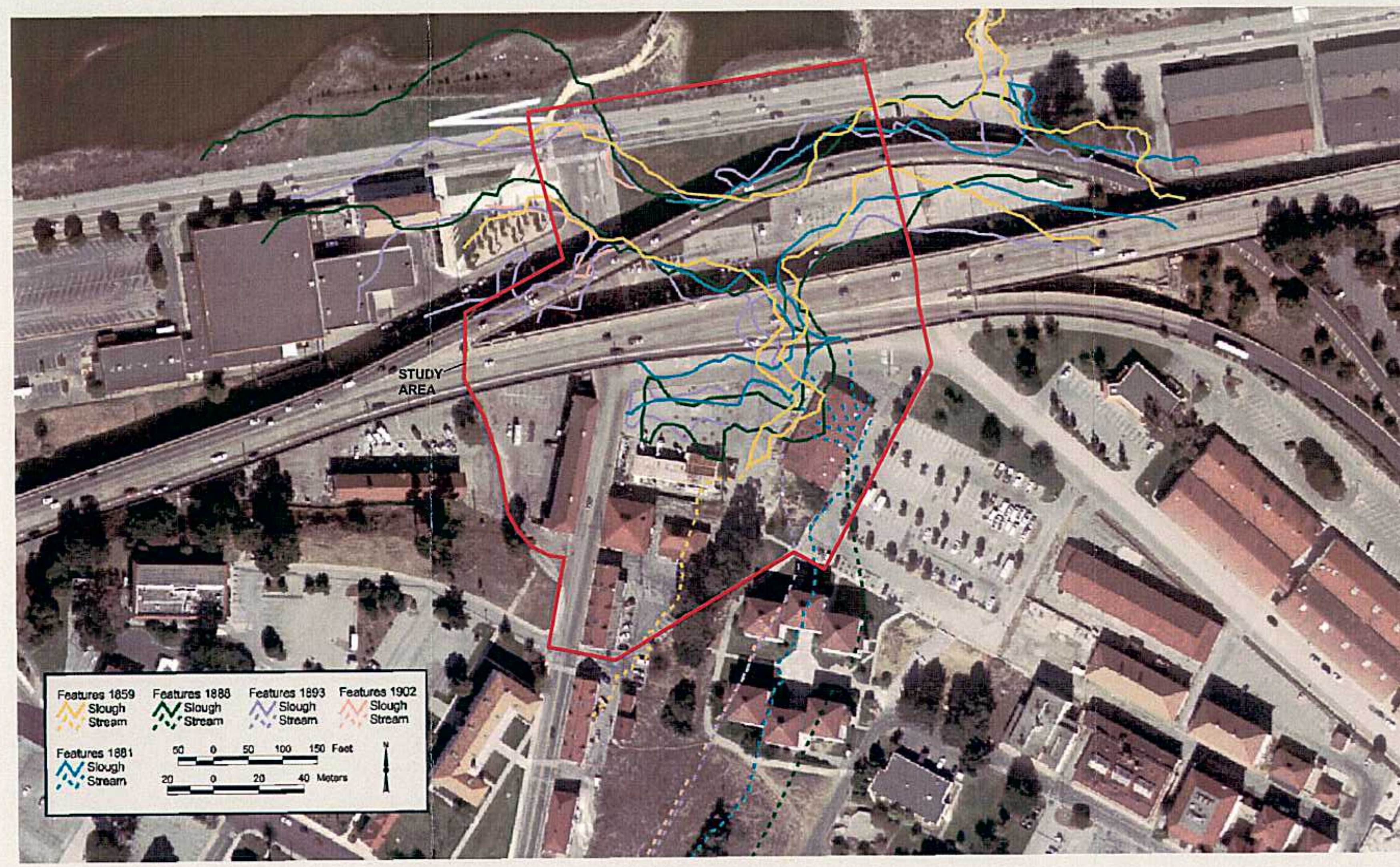
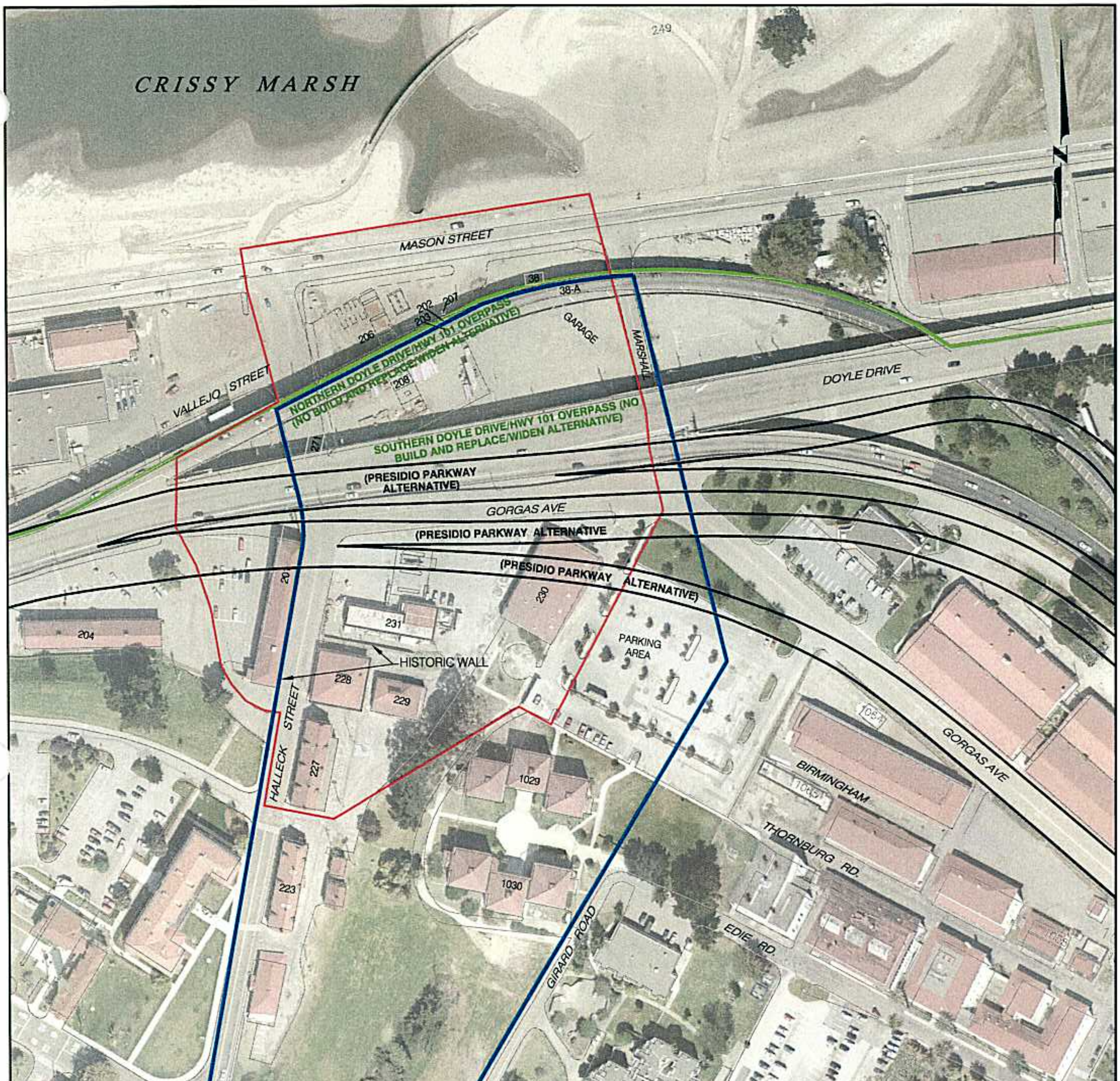




Note: Maps provided by the Presidio Trust

DRAWN: TJH	PROJECT NO: 4089041001 105	MACTEC	Corrective Action Plan Building 207/231 Area Presidio of San Francisco San Francisco, California	Historic Marshline/Fill Locations	PLATE 3b
ENGINEER:	SCALE: AS SHOWN				
CHECKED:	DATE: 7/2006				
APPROVED:	DATE:				

Presidio-plate3b.mxd 7/7/06



EXPLANATION

BUILDING 207/231 AREA (SITE)

TENNESSEE HOLLOW FRESH WATER ECOLOGICAL PROTECTION ZONE

CRISSY FIELD SALTWATER PROTECTION ZONE (NORTH OF GREEN LINE)

0 200 400

SCALE IN FEET

NOTE: AERIAL PHOTOGRAPHY DATA MARCH 24, 2000
SOURCE: PRESIDIO TRUST GIS DEPARTMENT.

4089041001026.DWG 1.0
20060707.0910

MACTEC

Doyle Drive/Highway 101 Alternatives
Corrective Action Plan
Building 207/231
Presidio of San Francisco
San Francisco, California

PLATE

4

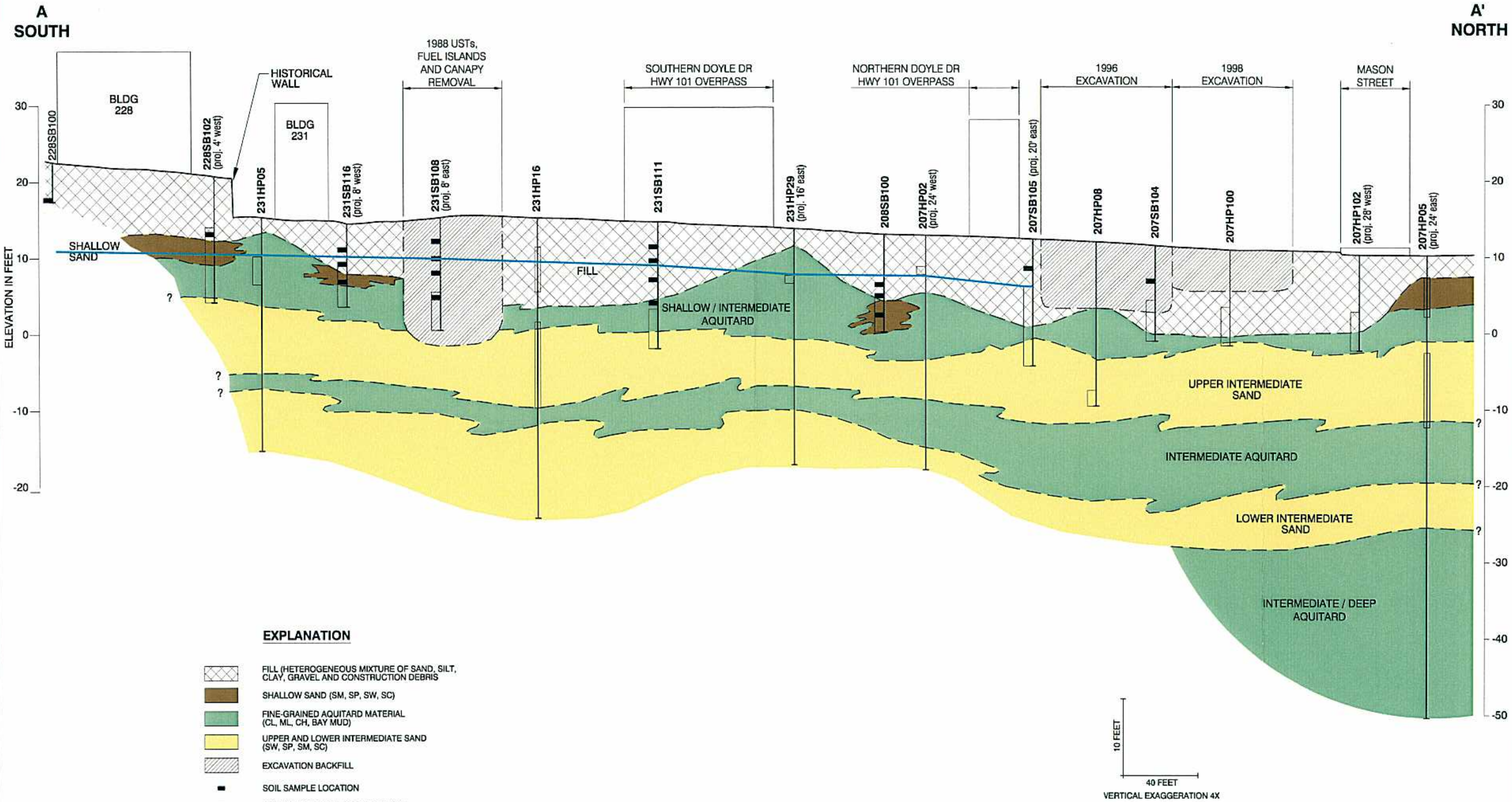
DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
PH	4089041001 106		07/06		

EXPLANATION

- MONITORING WELL - SHALLOW SAND
- MONITORING WELL - UPPER INTERMEDIATE SAND
- MONITORING WELL - LOWER INTERMEDIATE SAND
- MONITORING WELL - DECOMMISSIONED
- PIEZOMETER - DECOMMISSIONED
- PIEZOMETER - DECOMMISSIONED
- HYDROPUNCH
- GRAB GROUNDWATER SAMPLE
- SOIL BORING LOCATION
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- SVE AND GROUNDWATER INJECTION (IW) OR EXTRACTION (EW) WELL
- ARCHAEOLOGICAL CORE LOCATIONS
- T4-4 DOYLE STUDY SAMPLE ARCHAEOLOGICAL TRENCH
- FORMER RAILROAD TRACKS
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA
- STAINED AREA
- SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- REMOVED FUEL DISTRIBUTION PIPELINE
- ABANDONED IN-PLACE FUEL DISTRIBUTION PIPELINE
- SD TENNESSEE HOLLOW UNDERGROUND PIPELINE
- B—B' GEOLOGIC CROSS SECTION

NOTE:
AERIAL PHOTOGRAPHY DATA MARCH 24, 2000 SOURCE: PRESIDIO TRUST GIS DEPARTMENT.

DRAWN: PCB	PROJECT NO: 4089041001 106	MACTEC	Corrective Action Plan	Current and Previous Site Features	PLATE:
ENGINEER: NAM	SCALE: AS SHOWN		Building 207/231 Area Presidio of San Francisco San Francisco, California		5
CHECKED:	APPROVED:				
DATE: 07/05	DATE:				



EXPLANATION

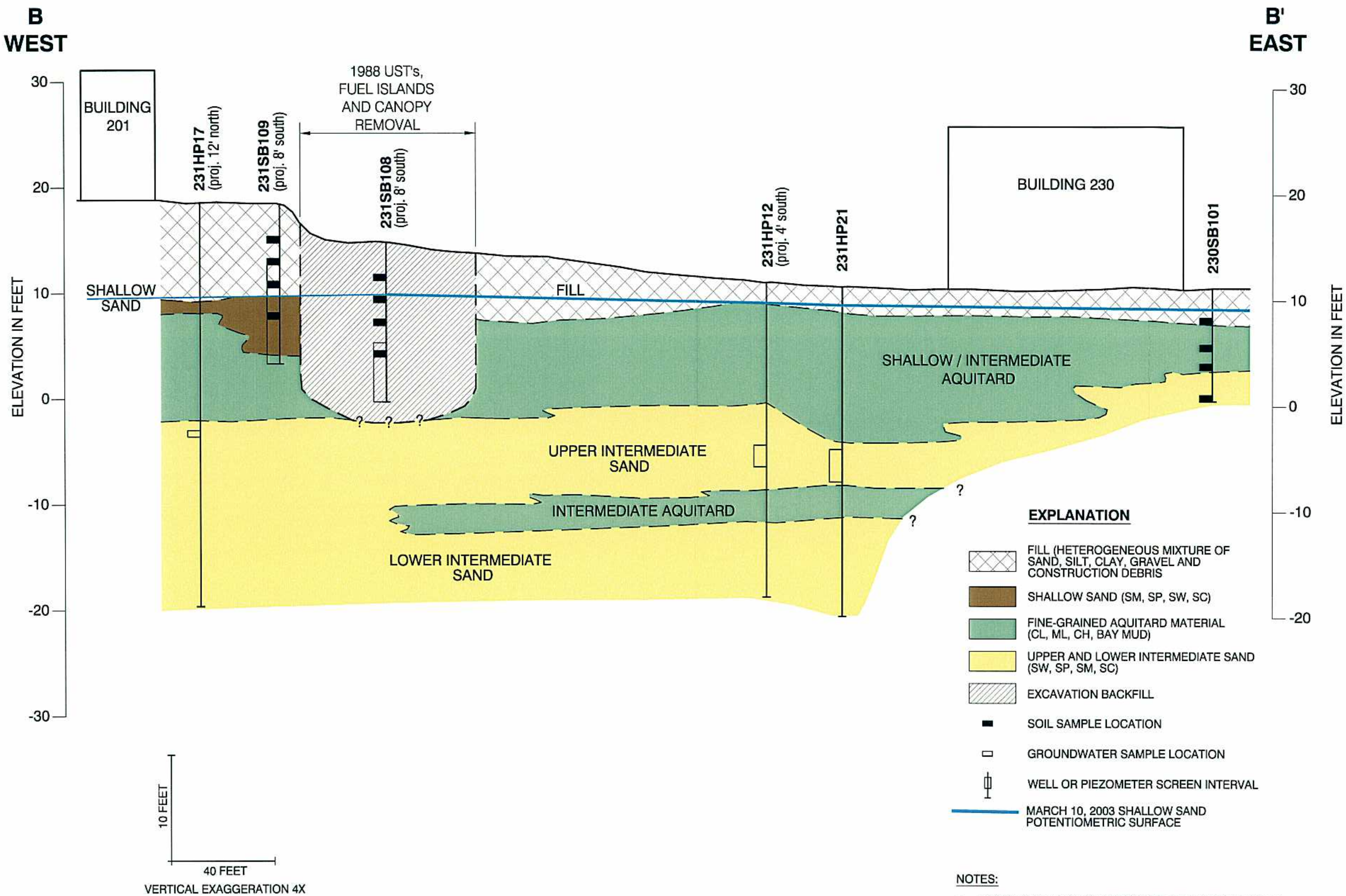
- FILL (HETEROGENEOUS MIXTURE OF SAND, SILT, CLAY, GRAVEL AND CONSTRUCTION DEBRIS
- SHALLOW SAND (SM, SP, SW, SC)
- FINE-GRAINED AQUITARD MATERIAL (CL, ML, CH, BAY MUD)
- UPPER AND LOWER INTERMEDIATE SAND (SW, SP, SM, SC)
- EXCAVATION BACKFILL
- SOIL SAMPLE LOCATION
- GROUNDWATER SAMPLE LOCATION
- WELL OR PIEZOMETER SCREEN INTERVAL
- MARCH 10, 2003 SHALLOW SAND POTENTIOMETRIC SURFACE

NOTES:

1. CROSS-SECTION LOCATIONS ARE SHOWN ON PLATE 5.
2. HORIZONTAL DATUM: NAD 27 CALIFORNIA STATE PLANE - ZONE 3
VERTICAL DATUM: PRESIDIO LOWER LOW WATER (PLLW).

4089041001014.DWG 1.0
20050713.1851

DRAWN: PH	PROJECT NO: 4089041001 106	MACTEC	Corrective Action Plan	Geologic Cross-Section A - A'	PLATE: 6
ENGINEER: NAM	SCALE: As Shown		Building 207/231 Area Presidio of San Francisco San Francisco, California		
CHECKED: AMC	APPROVED: MAJ				
DATE: 07/05	DATE: 07/05				

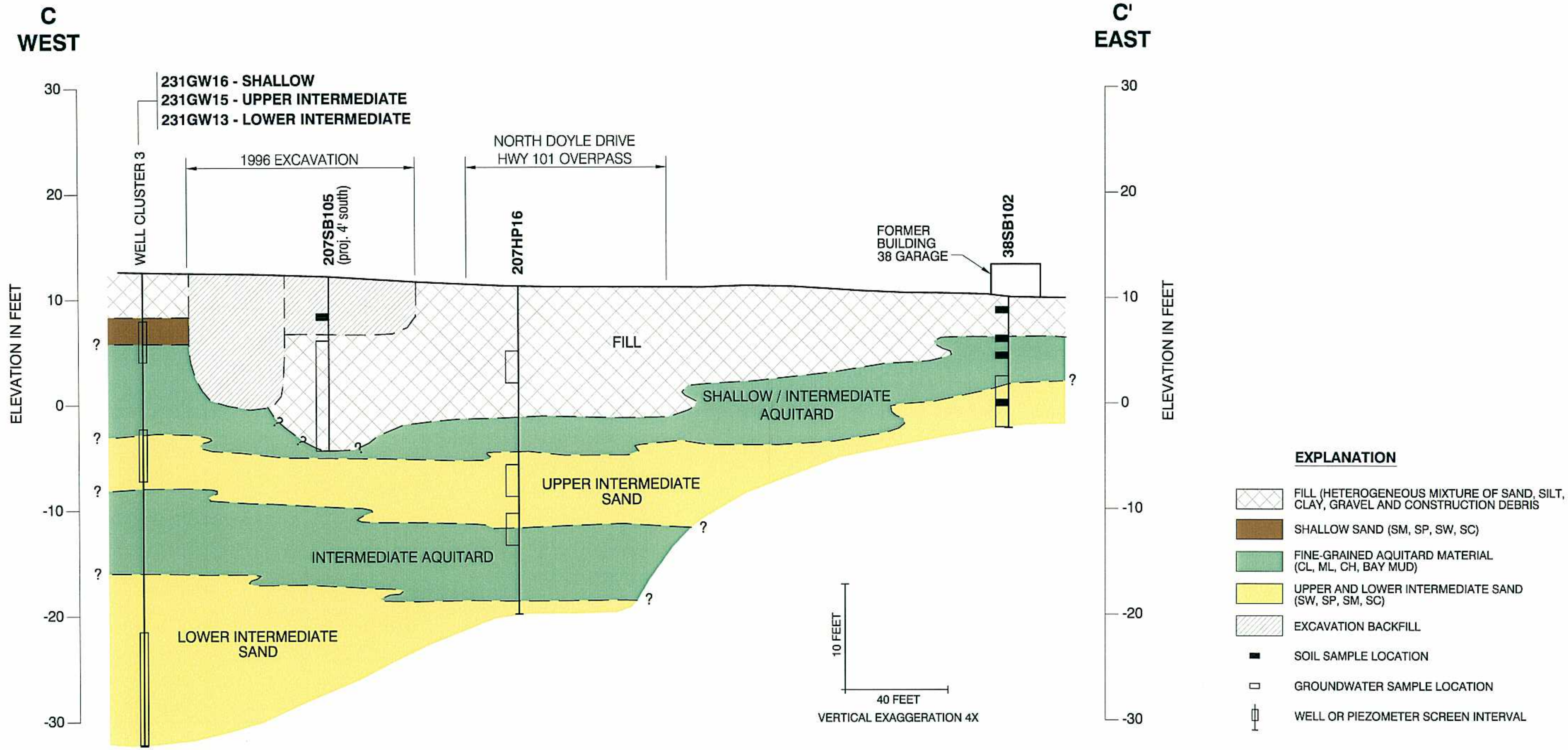


NOTES:

1. CROSS-SECTION LOCATIONS ARE SHOWN ON PLATE 5.
2. HORIZONTAL DATUM: NAD 27 CALIFORNIA STATE PLANE - ZONE 3, VERTICAL DATUM: PRESIDIO LOWER LOW WATER (PLLW).

4089041001016.DWG 40.0
20050714.0919

DRAWN: PH	PROJECT NO: 4089041001 106	MACTEC	Corrective Action Plan Building 207/231 Area Presidio of San Francisco San Francisco, California	Geologic Cross-Section B - B'	PLATE: 7
ENGINEER: NAM	SCALE: As Shown				
CHECKED: JML	APPROVED: MAJ				
DATE: 07/05	DATE: 07/05				

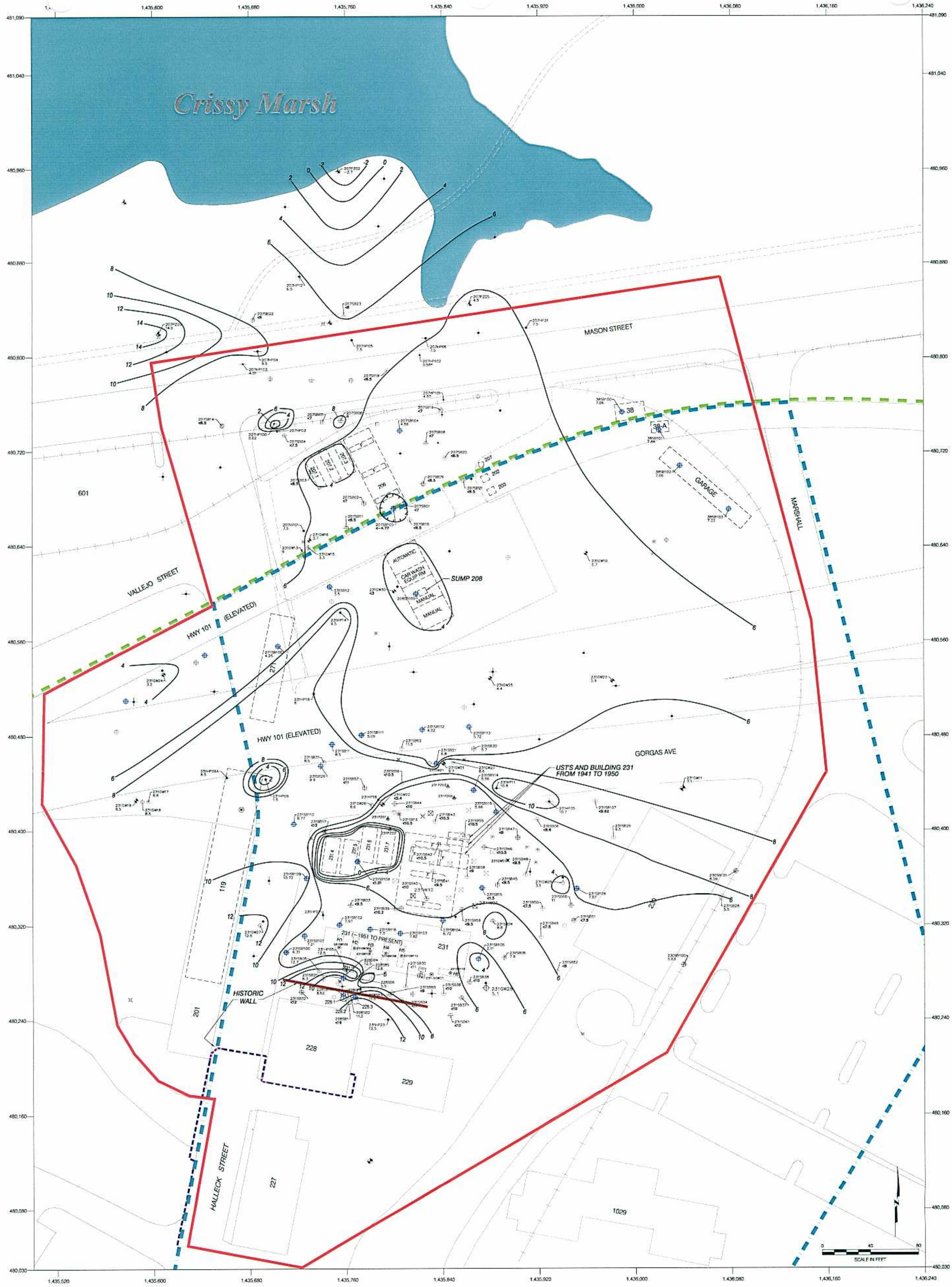


NOTES:

1. CROSS-SECTION LOCATIONS ARE SHOWN ON PLATE 5.
2. HORIZONTAL DATUM: NAD 27 CALIFORNIA STATE PLANE - ZONE 3
   VERTICAL DATUM: PRESIDIO LOWER LOW WATER (PLLW).

4089041001015.DWG 1.0
20050714.0922

DRAWN: PH	PROJECT NO: 4089041001 106	MACTEC	**Corrective Action Plan**	**Geologic Cross-Section C-C'**	PLATE: **8**
ENGINEER: NAM	SCALE: As Shown		Building 207/231 Area		
CHECKED: JAM	APPROVED: MAJ		Presidio of San Francisco		
DATE: 07/05	DATE: 07/05		San Francisco, California		



EXPLANATION

- MONITORING WELL - SHALLOW ZONE
- MONITORING WELL - INTERMEDIATE ZONES
- MONITORING WELL - DEEP ZONES
- MONITORING WELL - DECOMMISSIONED
- PIEZOMETER - DECOMMISSIONED
- PIEZOMETER - SHALLOW SAND
- SVE AND GROUNDWATER INJECTION (IW) OR EXTRACTION (EW) WELL
- HYDROPUNCH
- GRAB GROUNDWATER SAMPLE
- SOIL BORING LOCATION
- EXCAVATION SAMPLE LOCATION
- SOIL BORING WITH GRAB GROUNDWATER SAMPLE
- FORMER RAILROAD TRACKS
- FORMER HYDRAULIC LIFT
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA
- SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- HISTORIC WALL
- FORMER UNDERGROUND STORAGE TANK
- FORMER FUEL ISLAND
- REMOVED FUEL DISTRIBUTION PIPELINE
- ABANDONED IN-PLACE FUEL DISTRIBUTION PIPELINE
- 8 ELEVATION CONTOUR IN FEET PLLW

BAY MUD CONTOUR MAP NOTES:

1. Fill material consisted of industrial fill and dredged bay sands and clays.
2. Bay sands and clays were considered native based on the absence of brick debris, wire, or other non-native materials.
3. The depth to native material based on fill thicknesses detailed on early Building 207/231 Area boring logs reflected industrial fill only. For the purpose of this plate, the elevation of the top of native material does not include some units previously described as native. Decisions to expand fill content was based on observations from drilling activities performed in April 2004 and on comparisons from current to previous topography.
4. Many older borings were completed at depths less than 5-foot below ground surface. Most of these borings were interpreted as being completed above the fill/native interface. These and other borings that failed to penetrate the fill/native interface have a Bay Mud elevation listed as less than (<) the elevation of the bottom of the boring.
5. Based on the 1871 topographic map of the Presidio area, the Building 207/231 Area was submerged under water from Building 228 in the south to an east/west trending sand bar or island in the north. The 1871 elevation for the entire 207/231 Area was at or below the 6-foot contour line (assumed Mean Sea Level). For the purposes of this contour map, it was assumed that the original elevation for the 207/231Area was closer to 0 than 6-foot, based the area being submerged with water.
6. This is just one interpretation of the Bay Mud elevation and contouring. Other interpretations are possible.

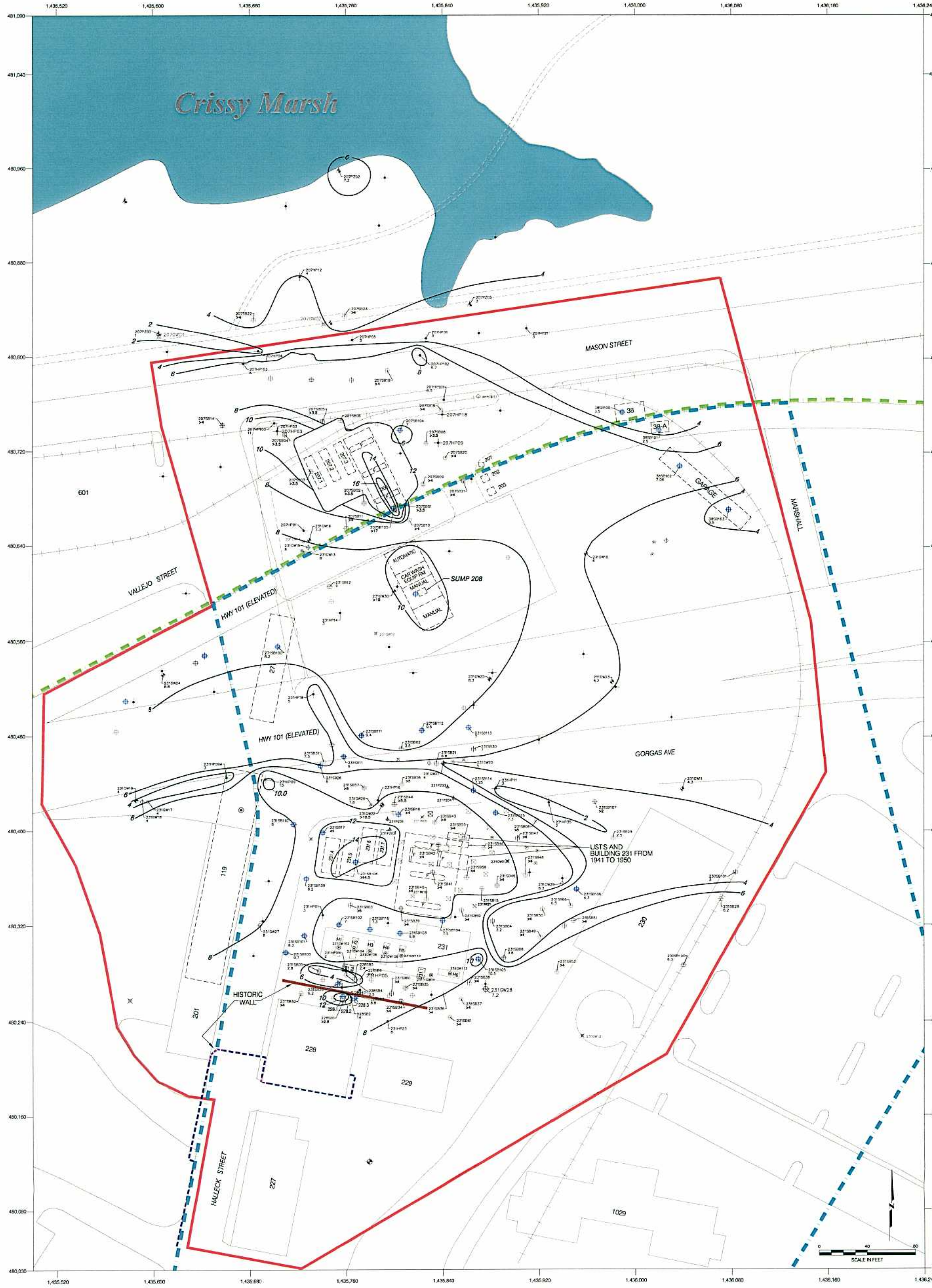
NOTE: LOCATIONS THAT ARE LABELED WERE USED IN CONTOURING.
* = NOT USED IN CONTOURING

MACTEC

Isopleth Map - Elevation of Top of Bay Mud
Corrective Action Plan
Building 207/231
Presidio of San Francisco
San Francisco, California

PLATE 9

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
CN	4089041001 106	AML	07/05	MAJ	07/05



EXPLANATION

- MONITORING WELL - SHALLOW SAND
- MONITORING WELL - UPPER INTERMEDIATE SAND
- MONITORING WELL - LOWER INTERMEDIATE SAND
- MONITORING WELL - DECOMMISSIONED
- PIEZOMETER - DECOMMISSIONED
- PIEZOMETER - SHALLOW SAND
- SVE AND GROUNDWATER INJECTION (IW) OR EXTRACTION (EW) WELL
- HYDROPUNCH
- GRAB GROUNDWATER SAMPLE
- SOIL BORING LOCATION
- EXCAVATION SAMPLE LOCATION
- SOIL BORING WITH GRAB GROUNDWATER SAMPLE
- FORMER RAILROAD TRACKS
- FORMER HYDRAULIC LIFT
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA
- SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- HISTORIC WALL
- FORMER UNDERGROUND STORAGE TANK
- FORMER FUEL ISLAND
- REMOVED FUEL DISTRIBUTION PIPELINE
- ABANDONED IN-PLACE FUEL DISTRIBUTION PIPELINE
- 8 THICKNESS CONTOUR IN FEET

THICKNESS OF FILL NOTES:

1. Fill material consisted of industrial fill and dredged bay sands and clays.
2. Bay derived sands and clays were considered fill based on the presence of brick debris, wire, or other non-native materials.
3. The fill thicknesses detailed on early Building 207/231 Area boring logs reflected industrial fill only. For the purpose of this plate, the thickness of fill from these borings was expanded to include portions of units previously described as native. Decisions to expand the fill content was based on observations from drilling activities performed in April 2004 and on comparisons from current to previous topography.
4. Many older borings were completed at depths less than 5-foot below ground surface. Most of these borings were interpreted as being completed above the fill/native interface. These and other borings that failed to penetrate the fill/native interface have fill thicknesses listed as greater than (>) the completion depth of the boring.
5. Based on the 1871 topographic map of the Presidio area, the Bulding 207/231 Area was submerged under water from Building 228 in the south to an east/west trending sand bar or island in the north. The 1871 elevation for the entire 207/231 Area was at or below the 6-foot contour line (assumed Mean Sea Level). For the purposes of this contour map, it was assumed that the original elevation for the 207/231Area was closer to 0 than 6-foot, based the area being submerged with water.
6. This is just one interpretation of fill thickness and contouring. Other interpretations are possible.

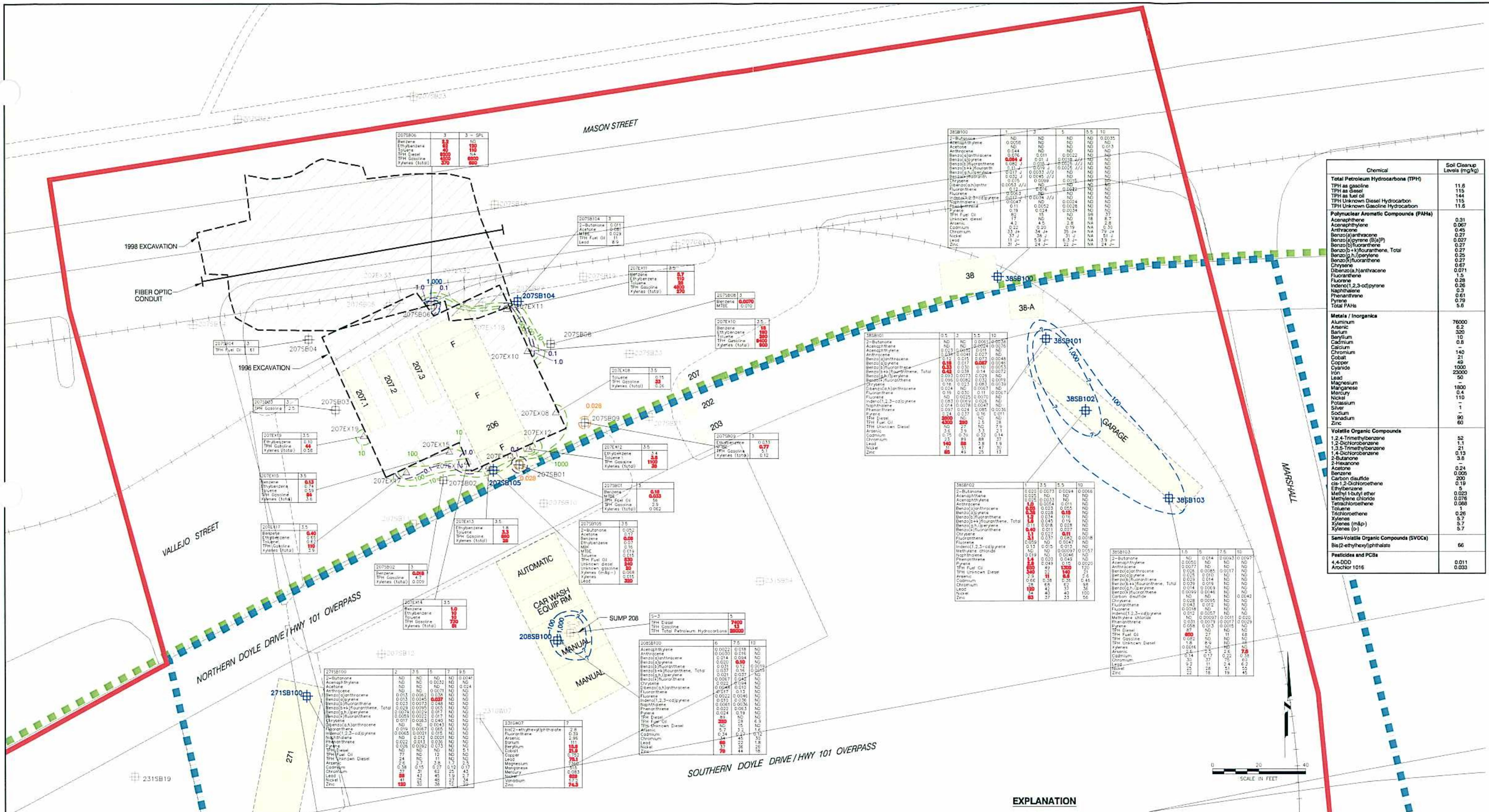
NOTE: LOCATIONS THAT ARE LABELED WERE USED IN CONTOURING.

MACTEC

Isopach Map - Thickness of Fill
Corrective Action Plan
Building 207/231
Presidio of San Francisco
San Francisco, California

PLATE 10

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
CN	4089041001 106	AML	07/05	MAJ	07/05



Chemical	Soil Cleanup Levels (mg/kg)
Total Petroleum Hydrocarbons (TPH)	
TPH as gasoline	11.6
TPH as diesel	115
TPH as fuel oil	144
TPH Unknown Diesel Hydrocarbon	115
TPH Unknown Gasoline Hydrocarbon	11.6
Polynuclear Aromatic Compounds (PAHs)	
Acenaphthene	0.31
Acenaphthylene	0.067
Anthracene	0.45
Benzo(a)anthracene	0.27
Benzo(a)pyrene (B[a]P)	0.027
Benzo(b)fluoranthene	0.27
Benzo(b+k)flouranthene, Total	0.27
Benzo(g,h,i)perylene	0.25
Benzo(k)fluoranthene	0.27
Chrysene	0.67
Dibenzo(a,h)anthracene	0.071
Fluoranthene	1.5
Fluorene	0.28
Indeno(1,2,3-cd)pyrene	0.26
Naphthalene	0.3
Phenanthrene	0.61
Pyrene	0.79
Total PAHs	5.6
Metals / Inorganics	
Aluminum	76000
Arsenic	6.2
Barium	320
Beryllium	10
Cadmium	0.8
Calcium	–
Chromium	140
Cobalt	21
Copper	49
Cyanide	1000
Iron	23000
Lead	50
Magnesium	–
Manganese	1800
Mercury	0.4
Nickel	110
Potassium	–
Silver	1
Sodium	–
Vanadium	90
Zinc	60
Volatile Organic Compounds	
1,2,4-Trimethylbenzene	52
1,2-Dichlorobenzene	1.1
1,3,5-Trimethylbenzene	21
1,4-Dichlorobenzene	0.13
2-Butanone	3.8
2-Hexanone	–
Acetone	0.24
Benzene	0.005
Carbon disulfide	200
cis-1,2-Dichloroethene	0.19
Ethylbenzene	5
Methyl t-butyl ether	0.023
Methylene chloride	0.076
Tetrachloroethene	0.088
Toluene	1
Trichloroethene	0.26
Xylenes	5.7
Xylenes (m&p-)	5.7
Xylenes (o-)	5.7
Semi-Volatile Organic Compounds (SVOCs)	
Bis(2-ethylhexyl)phthalate	66
Pesticides and PCBs	
4,4-DDD	0.011
Arochlor 1016	0.033

EXPLANATION

- SOIL BORING LOCATION
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA BOUNDARY
- SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- FORMER UNDERGROUND STORAGE TANK
- FORMER FUEL ISLAND
- FORMER RAILROAD TRACKS
- PREVIOUS SOIL EXCAVATION AREA
- 1,000 TPH DIESEL AND/OR FUEL OIL CONCENTRATION CONTOUR (mg/kg)
- 100 GASOLINE CONCENTRATION CONTOUR (mg/kg)
- 1 BENZENE CONCENTRATION CONTOUR (mg/kg)
- 0.028 MTBE CONCENTRATION CONTOUR (mg/kg)

207SB02	3
Benzene	0.018

STATION
SAMPLE DEPTH (FEET BGS)
ALL CONCENTRATIONS IN MILLIGRAMS PER KILOGRAM (mg/kg)
ANALYTE

- CONCENTRATIONS SHOWN IN RED EXCEED CLEANUP LEVELS.
- SPL = Split
- NA = NOT ANALYZED
- ND = NOT DETECTED

NOTES:
1. ONLY RESULTS THAT WERE DETECTED ARE SHOWN.
2. THIS REPRESENTS ONE INTERPRETATION OF A LIMITED DATA SET; OTHER INTERPRETATIONS ARE POSSIBLE.

NO.	DATE	REVISIONS	BY	CHK

DRAWN: CN | PROJECT NO: 4089041001 106
ENGINEER: NAM | SCALE: AS SHOWN
CHECKED: | APPROVED:
DATE: | DATE:

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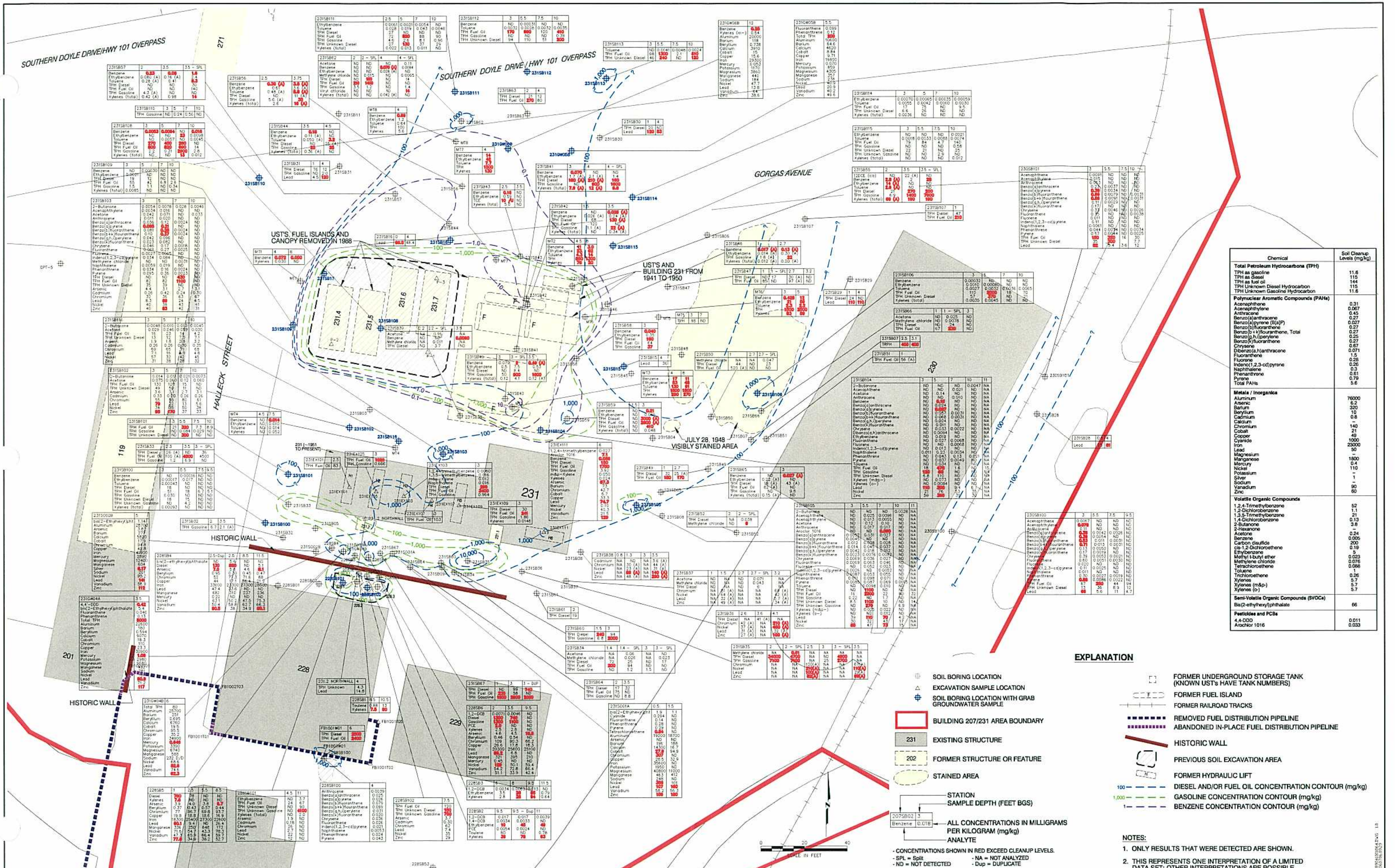
Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Organic Compounds and Metals Detected in Soil
Building 207 Area

PLATE: **11a**



Chemical	Soil Cleanup Levels (mg/kg)
Total Petroleum Hydrocarbons (TPH)	
TPH as gasoline	11.6
TPH as diesel	115
TPH as fuel oil	144
TPH Unknown Diesel Hydrocarbon	115
TPH Unknown Gasoline Hydrocarbon	11.6
Polynuclear Aromatic Compounds (PAHs)	
Acenaphthene	0.31
Acenaphthylene	0.067
Anthracene	0.45
Benzo(a)anthracene	0.27
Benzo(a)pyrene (B[a]P)	0.027
Benzo(b)fluoranthene	0.27
Benzo(b+k)flouranthene, Total	0.27
Benzo(g,h,i)perylene	0.25
Benzo(k)fluoranthene	0.27
Chrysene	0.67
Dibenzo(a,h)anthracene	0.071
Fluoranthene	1.5
Fluorene	0.28
Indeno(1,2,3-cd)pyrene	0.26
Naphthalene	0.3
Phenanthrene	0.61
Pyrene	0.79
Total PAHs	5.6
Metals / Inorganics	
Aluminum	76000
Arsenic	6.2
Barium	320
Beryllium	10
Cadmium	0.8
Calcium	–
Chromium	140
Cobalt	21
Copper	49
Cyanide	1000
Iron	23000
Lead	50
Magnesium	–
Manganese	1800
Mercury	0.4
Nickel	110
Potassium	–
Silver	1
Sodium	–
Vanadium	90
Zinc	60
Volatile Organic Compounds	
1,2,4-Trimethylbenzene	52
1,2-Dichlorobenzene	1.1
1,3,5-Trimethylbenzene	21
1,4-Dichlorobenzene	0.13
2-Butanone	3.8
2-Hexanone	–
Acetone	0.24
Benzene	0.005
Carbon disulfide	200
cis-1,2-Dichloroethene	0.19
Ethylbenzene	5
Methyl t-butyl ether	0.023
Methylene chloride	0.076
Tetrachloroethene	0.088
Toluene	1
Trichloroethene	0.26
Xylenes	5.7
Xylenes (m&p-)	5.7
Xylenes (o-)	5.7
Semi-Volatile Organic Compounds (SVOCs)	
Bis(2-ethylhexyl)phthalate	66
Pesticides and PCBs	
4,4-DDD	0.011
Arochlor 1016	0.033

EXPLANATION

- SOIL BORING LOCATION
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- BUILDING 207/231 AREA BOUNDARY
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- STAINED AREA
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- FORMER FUEL ISLAND
- FORMER RAILROAD TRACKS
- REMOVED FUEL DISTRIBUTION PIPELINE
- ABANDONED IN-PLACE FUEL DISTRIBUTION PIPELINE
- HISTORIC WALL
- PREVIOUS SOIL EXCAVATION AREA
- FORMER HYDRAULIC LIFT
- 100 — DIESEL AND/OR FUEL OIL CONCENTRATION CONTOUR (mg/kg)
- 1,000 — GASOLINE CONCENTRATION CONTOUR (mg/kg)
- 1 — BENZENE CONCENTRATION CONTOUR (mg/kg)

207SB02	3
Benzene	0.018

- STATION
- SAMPLE DEPTH (FEET BGS)
- ALL CONCENTRATIONS IN MILLIGRAMS PER KILOGRAM (mg/kg)
- ANALYTE

- CONCENTRATIONS SHOWN IN RED EXCEED CLEANUP LEVELS.
- SPL = Split
- ND = NOT DETECTED
- NA = NOT ANALYZED
- Dup = DUPLICATE

0 20 40
SCALE IN FEET

NOTES:

1. ONLY RESULTS THAT WERE DETECTED ARE SHOWN.
2. THIS REPRESENTS ONE INTERPRETATION OF A LIMITED DATA SET; OTHER INTERPRETATIONS ARE POSSIBLE.

NO.	DATE	REVISIONS	BY	CHK

DRAWN:	CN	PROJECT NO:	4089041001 106
ENGINEER:	NAM	SCALE:	AS SHOWN
CHECKED:		APPROVED:	
DATE:		DATE:	

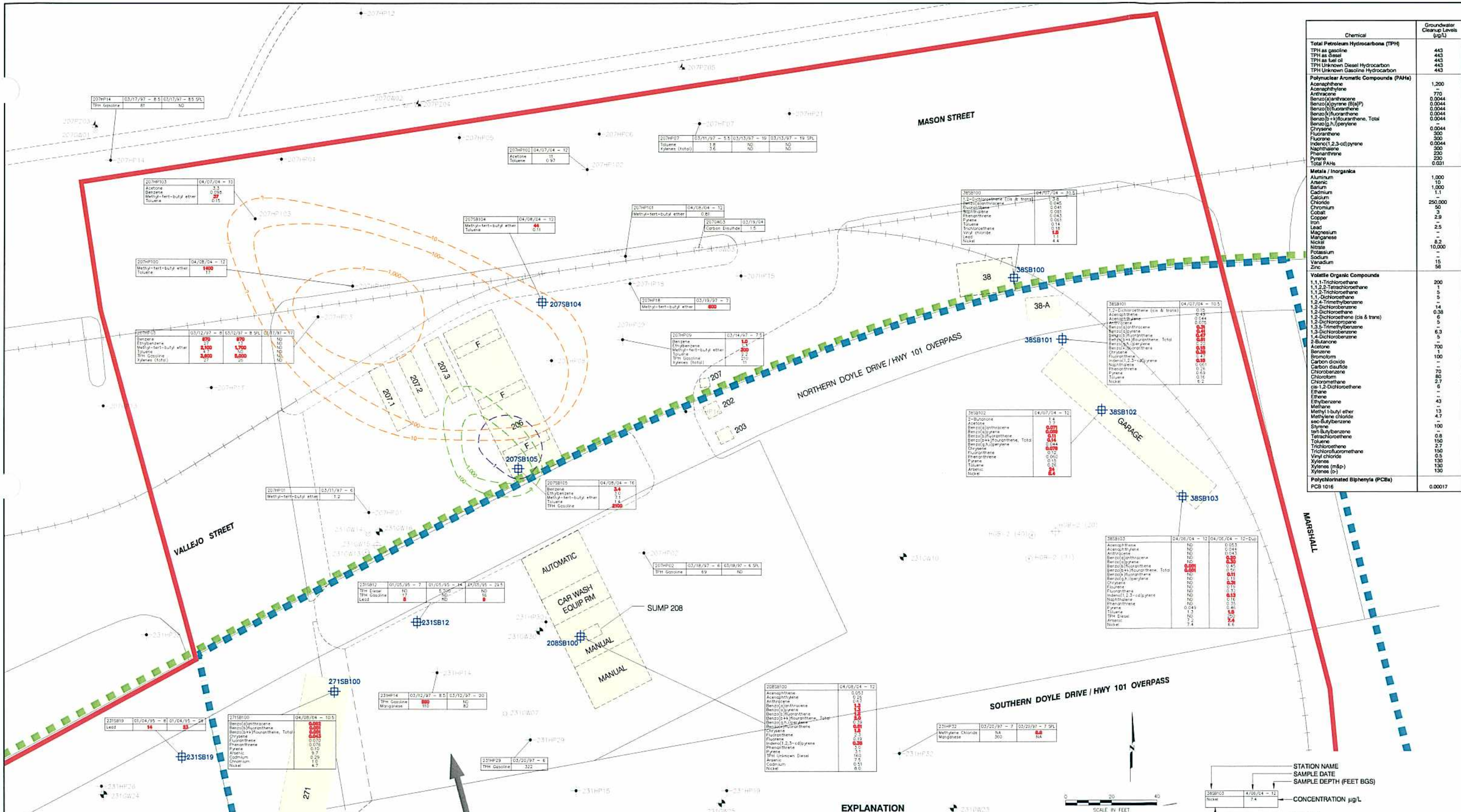
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Organic Compounds and Metals Detected in Soil
Building 231 Area

PLATE: **11b**



Chemical	Groundwater Cleanup Levels (µg/L)
Total Petroleum Hydrocarbons (TPH)	
TPH as gasoline	443
TPH as diesel	443
TPH as fuel oil	443
TPH Unknown Diesel Hydrocarbon	443
TPH Unknown Gasoline Hydrocarbon	443
Polynuclear Aromatic Compounds (PAHs)	
Acenaphthene	1,200
Acenaphthylene	--
Anthracene	770
Benzo(a)anthracene	0.0044
Benzo(a)pyrene (B[a]P)	0.0044
Benzo(b)fluoranthene	0.0044
Benzo(k)fluoranthene	0.0044
Benzo(b+k)flouranthene, Total	0.0044
Benzo(g,h,i)perylene	--
Chrysene	0.0044
Fluoranthene	300
Fluorene	300
Indeno(1,2,3-cd)pyrene	0.0044
Naphthalene	300
Phenanthrene	230
Pyrene	230
Total PAHs	0.031
Metals / Inorganics	
Aluminum	1,000
Arsenic	10
Barium	1,000
Cadmium	1.1
Calcium	--
Chloride	250,000
Chromium	50
Cobalt	3
Copper	2.9
Iron	--
Lead	2.5
Magnesium	--
Manganese	--
Nickel	8.2
Nitrate	10,000
Potassium	--
Sodium	--
Vanadium	15
Zinc	58
Volatile Organic Compounds	
1,1,1-Trichloroethane	200
1,1,2,2-Tetrachloroethane	1
1,1,2-Trichloroethane	5
1,1,-Dichloroethane	5
1,2,4-Trimethylbenzene	--
1,2-Dichlorobenzene	14
1,2-Dichloroethane	0.38
1,2-Dichloroethene (cis & trans)	6
1,2-Dichloropropane	5
1,3,5-Trimethylbenzene	--
1,3-Dichlorobenzene	6.3
1,4-Dichlorobenzene	5
2-Butanone	--
Acetone	700
Benzene	1
Bromoform	100
Carbon dioxide	--
Carbon disulfide	--
Chlorobenzene	70
Chloroform	80
Chloromethane	2.7
cis-1,2-Dichloroethene	6
Ethane	--
Ethene	--
Ethylbenzene	43
Methane	--
Methyl t-butyl ether	13
Methylene chloride	4.7
sec-Butylbenzene	--
Styrene	100
tert-Butylbenzene	--
Tetrachloroethene	0.8
Toluene	150
Trichloroethene	2.7
Trichlorofluoromethane	150
Vinyl chloride	0.5
Xylenes	130
Xylenes (m&p-)	130
Xylenes (o-)	130
Polychlorinated Biphenyls (PCBs)	
PCB 1016	0.00017

EXPLANATION

- MONITORING WELL - SHALLOW SAND
- MONITORING WELL - UPPER INTERMEDIATE SAND
- MONITORING WELL - LOWER INTERMEDIATE SAND
- MONITORING WELL - DECOMMISSIONED
- PIEZOMETER - DECOMMISSIONED
- HYDROPUNCH
- SOIL BORING LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE

- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA BOUNDARY
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)

- FORMER FUEL ISLAND
- FORMER RAILROAD TRACKS
- APPROXIMATE DIRECTION OF SHALLOW ZONE GROUNDWATER FLOW MAY 24, 2004
- 1,000 MTBE CONCENTRATION CONTOUR (µg/L)
- 100 BENZENE CONCENTRATION CONTOUR (µg/L)
- 1 GASOLINE CONCENTRATION CONTOUR (µg/L)

0 20 40
SCALE IN FEET

STATION NAME
SAMPLE DATE
SAMPLE DEPTH (FEET BGS)

38SB103	4/06/04 - 12
Nickel	7.4

CONCENTRATION µg/L
ANALYTE

- ALL RESULTS IN MICROGRAMS PER LITER (µg/L)
- CONCENTRATIONS SHOWN IN RED EXCEED CLEANUP LEVELS.
- SPL = Split
- ND = NOT DETECTED
- NA = NOT ANALYZED
- Dup = DUPLICATE

NOTES:

1. THIS REPRESENTS ONE INTERPRETATION OF A LIMITED DATA SET; OTHER INTERPRETATIONS ARE POSSIBLE.
2. ONLY RESULTS THAT WERE DETECTED ARE SHOWN.
3. CONTOURS ARE BASED ON THE 5 MOST RECENT YEARS OF DATA. DATA PRIOR TO 5 YEARS IS POSTED, BUT WAS NOT CONTOURED.
4. POSTED GROUNDWATER ANALYTICAL DATA REPRESENTS THE MOST RECENT DATA AVAILABLE.

NO.	DATE	REVISIONS	BY	CHK

DRAWN: PH
ENGINEER: NAM
CHECKED:
DATE:
PROJECT NO: 4089041001 106
SCALE: AS SHOWN
APPROVED:
DATE:

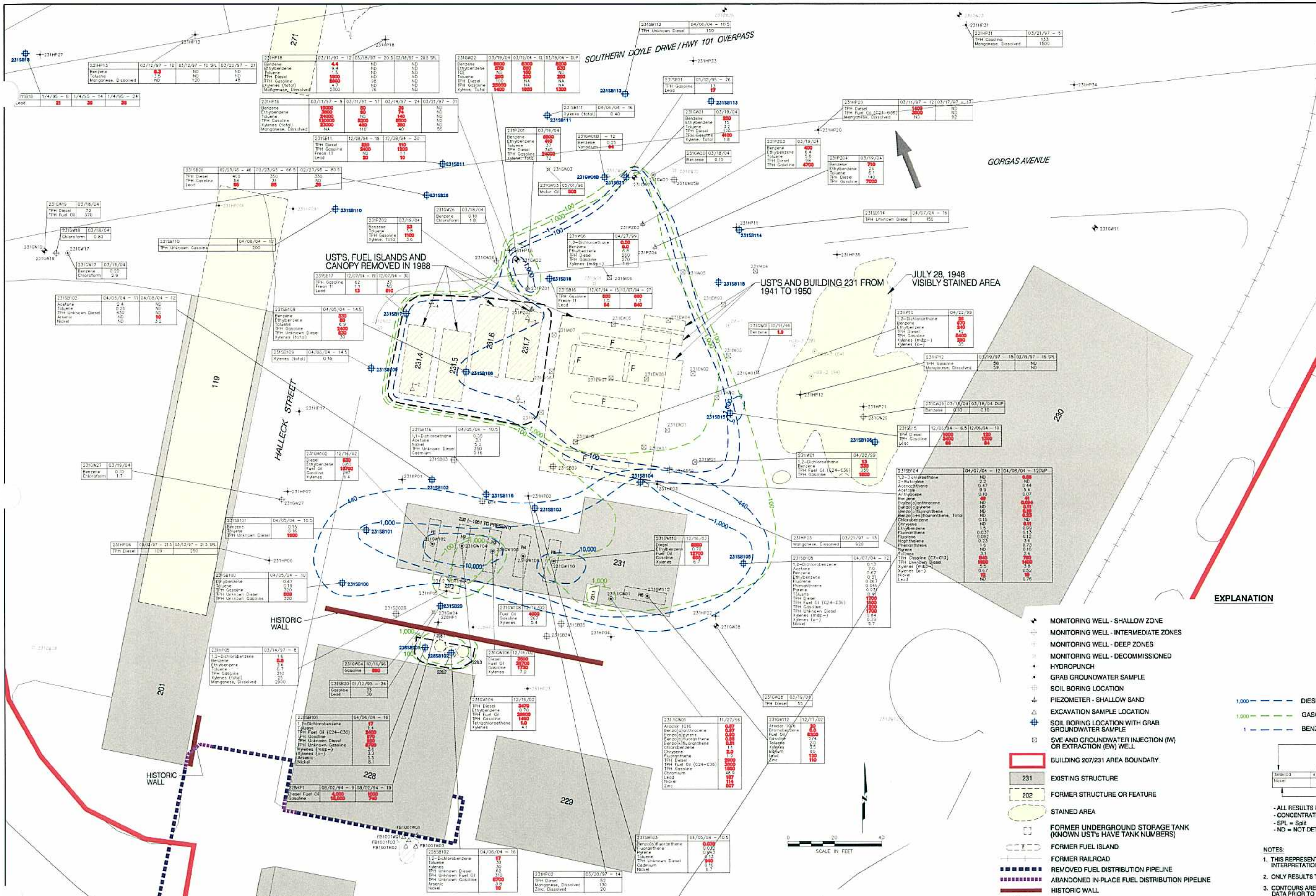
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Organic Compounds and Metals Detected In Shallow Groundwater Building 207 Area

PLATE: **12a**



Chemical	Groundwater Cleanup Levels (µg/L)
Total Petroleum Hydrocarbons (TPH)	
TPH as gasoline	443
TPH as diesel	443
TPH as fuel oil	443
TPH Unknown Diesel Hydrocarbon	443
TPH Unknown Gasoline Hydrocarbon	443
Polynuclear Aromatic Compounds (PAHs)	
Acenaphthene	1,200
Acenaphthylene	--
Anthracene	770
Benzo(a)anthracene	0.0044
Benzo(a)pyrene (B[a]P)	0.0044
Benzo(b)fluoranthene	0.0044
Benzo(k)fluoranthene	0.0044
Benzo(b+k)flouranthene, Total	0.0044
Benzo(g,h,i)perylene	--
Chrysene	0.0044
Fluoranthene	300
Fluorene	300
Indeno(1,2,3-cd)pyrene	0.0044
Naphthalene	300
Phenanthrene	230
Pyrene	230
Total PAHs	0.031
Metals / Inorganics	
Aluminum	1,000
Arsenic	10
Barium	1,000
Cadmium	1.1
Calcium	--
Chloride	250,000
Chromium	50
Cobalt	3
Copper	2.9
Iron	--
Lead	2.5
Magnesium	--
Manganese	--
Nickel	8.2
Nitrate	10,000
Potassium	--
Sodium	--
Vanadium	15
Zinc	58
Volatile Organic Compounds	
1,1,1-Trichloroethane	200
1,1,2,2-Tetrachloroethane	1
1,1,2-Trichloroethane	5
1,1,-Dichloroethane	5
1,2,4-Trimethylbenzene	--
1,2-Dichlorobenzene	14
1,2-Dichloroethane	0.38
1,2-Dichloroethene (cis & trans)	6
1,2-Dichloropropane	5
1,3,5-Trimethylbenzene	--
1,3-Dichlorobenzene	6.3
1,4-Dichlorobenzene	5
2-Butanone	--
Acetone	700
Benzene	1
Bromoform	100
Carbon dioxide	--
Carbon disulfide	--
Chlorobenzene	70
Chloroform	80
Chloromethane	2.7
cis-1,2-Dichloroethene	6
Ethane	--
Ethene	--
Ethylbenzene	43
Methane	--
Methyl t-butyl ether	13
Methylene chloride	4.7
sec-Butylbenzene	--
Styrene	100
tert-Butylbenzene	--
Tetrachloroethene	0.8
Toluene	150
Trichloroethene	2.7
Trichlorofluoromethane	150
Vinyl chloride	0.5
Xylenes	130
Xylenes (m&p-)	130
Xylenes (o-)	130
Polychlorinated Biphenyls (PCBs)	
PCB 1016	0.00017

EXPLANATION

- MONITORING WELL - SHALLOW ZONE
- MONITORING WELL - INTERMEDIATE ZONES
- MONITORING WELL - DEEP ZONES
- MONITORING WELL - DECOMMISSIONED
- HYDROPUNCH
- GRAB GROUNDWATER SAMPLE
- SOIL BORING LOCATION
- PIEZOMETER - SHALLOW SAND
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- SVE AND GROUNDWATER INJECTION (IW) OR EXTRACTION (EW) WELL
- BUILDING 207/231 AREA BOUNDARY
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- STAINED AREA
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- FORMER FUEL ISLAND
- FORMER RAILROAD
- REMOVED FUEL DISTRIBUTION PIPELINE
- ABANDONED IN-PLACE FUEL DISTRIBUTION PIPELINE
- HISTORIC WALL
- PREVIOUS SOIL EXCAVATION AREA
- FORMER HYDRAULIC LIFT
- APPROXIMATE DIRECTION OF SHALLOW ZONE GROUNDWATER FLOW MAY 24, 2004

1,000 DIESEL AND/OR FUEL OIL CONCENTRATION CONTOUR (µg/L)
1,000 GASOLINE CONCENTRATION CONTOUR (µg/L)
1 BENZENE CONCENTRATION CONTOUR (µg/L)

STATION NAME
SAMPLE DATE
SAMPLE DEPTH (FEET BGS)
CONCENTRATION
ANALYTE
- NA = NOT ANALYZED
- Dup = DUPLICATE

38SB103	4/06/04 - 12
Nickel	7.4

- ALL RESULTS IN MICROGRAMS PER LITER (µg/L)
- CONCENTRATIONS SHOWN IN RED EXCEED CLEANUP LEVELS
- SPL = Split
- ND = NOT DETECTED

NOTES:

1. THIS REPRESENTS ONE INTERPRETATION OF A LIMITED DATA SET; OTHER INTERPRETATIONS ARE POSSIBLE.
2. ONLY RESULTS THAT WERE DETECTED ARE SHOWN.
3. CONTOURS ARE BASED ON THE 5 MOST RECENT YEARS OF DATA. DATA PRIOR TO 5 YEARS IS POSTED BUT WAS NOT CONTOURED.
4. POSTED GROUNDWATER ANALYTICAL DATA REPRESENTS THE MOST RECENT DATA AVAILABLE.

NO.	DATE	REVISIONS	BY	CHK	DRAWN: CN	PROJECT NO: 4089041001 106
					ENGINEER: NAM	SCALE: AS SHOWN
					CHECKED:	APPROVED:
					DATE:	DATE:

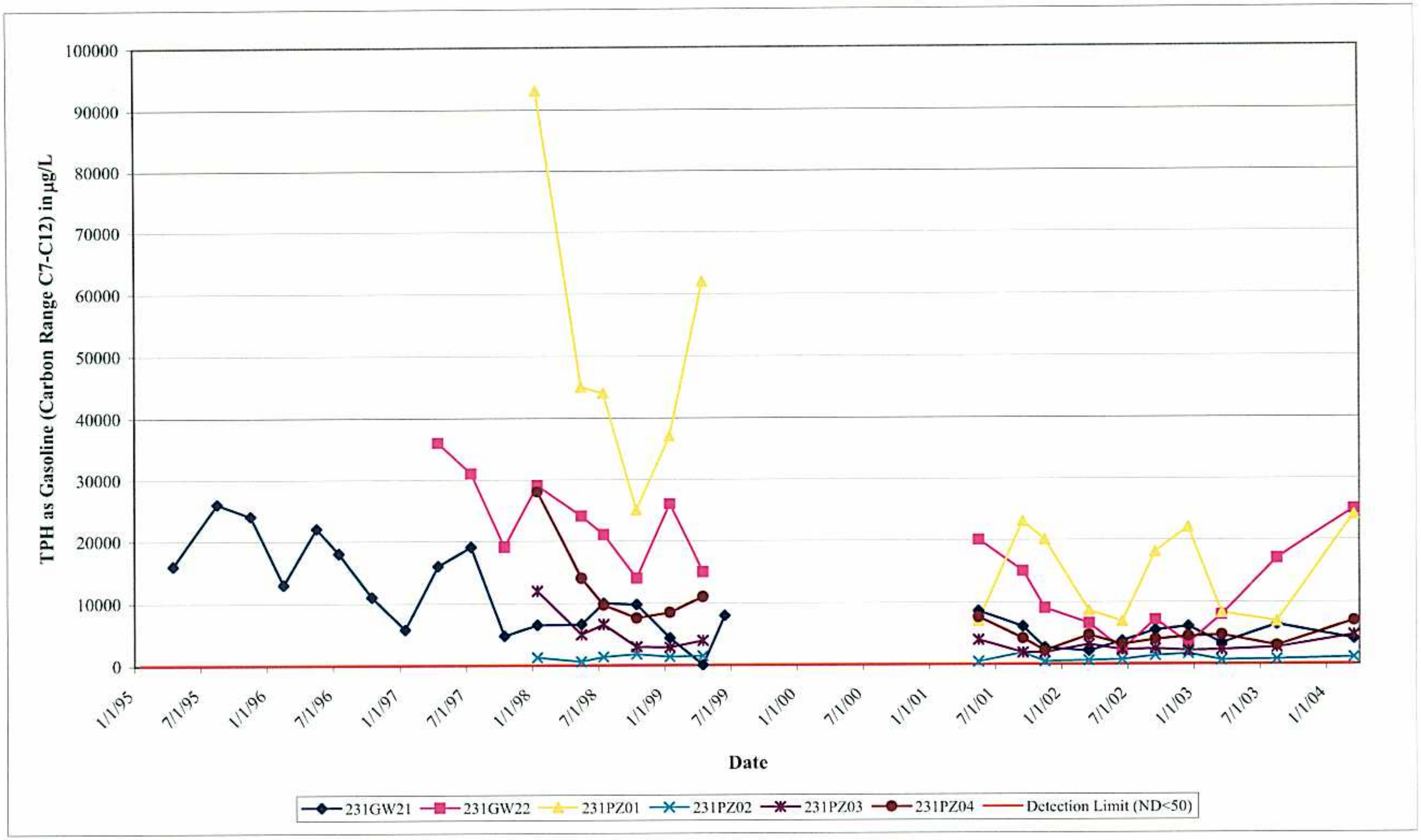
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Organic Compounds and Metals Detected In Groundwater
Building 231 Area

PLATE: **12b**



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Historic Concentrations of TPH as Gasoline in Groundwater

Shallow Sand Aquifer

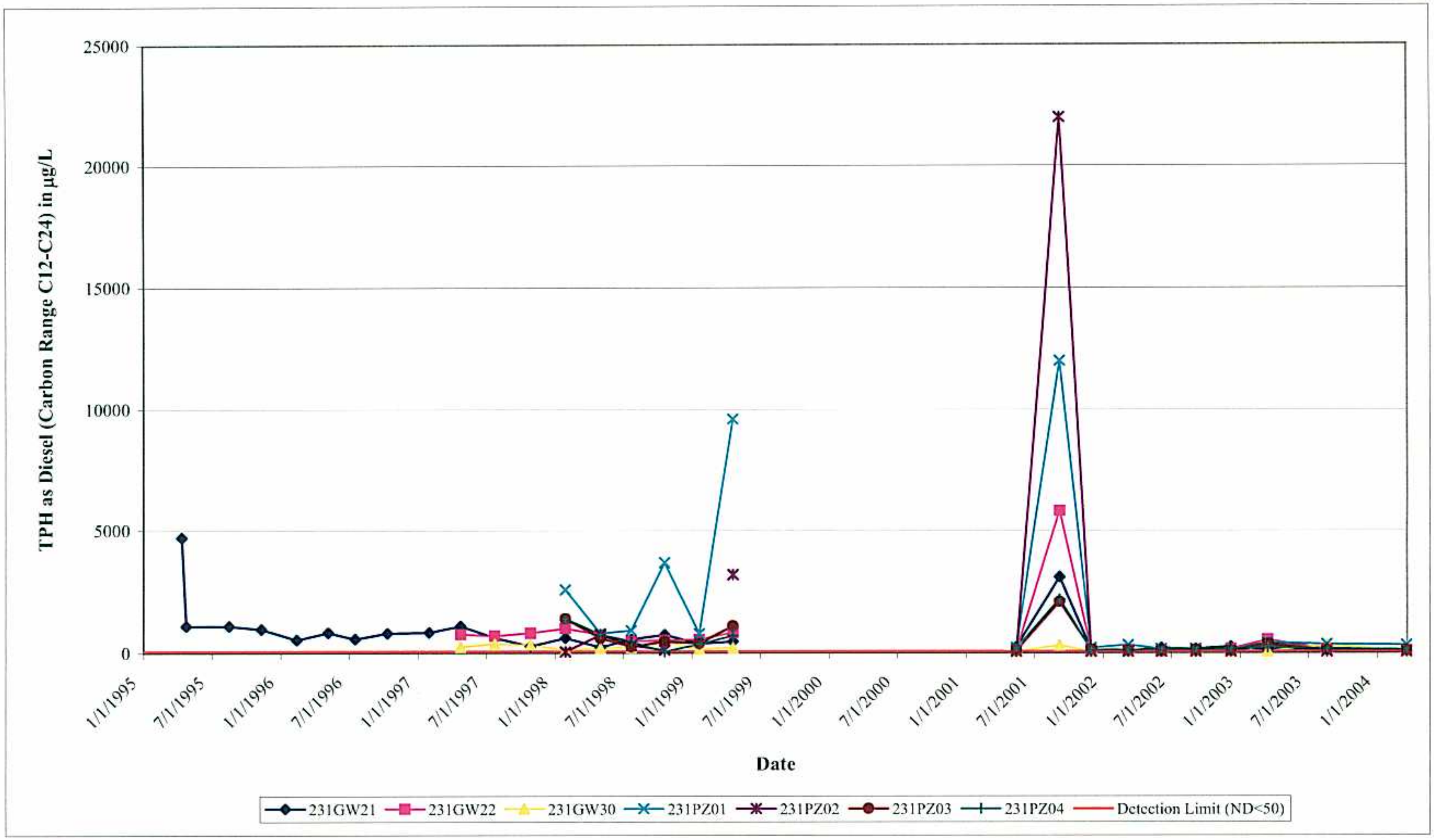
Corrective Action Plan Building 207/231

Presidio of San Francisco, San Francisco, California

PLATE

13

DRAWN BY	JOB NUMBER	Checked	Approved	Date	Revised Date
NAM	4089041001 106	JMC	MAJ	7/05	

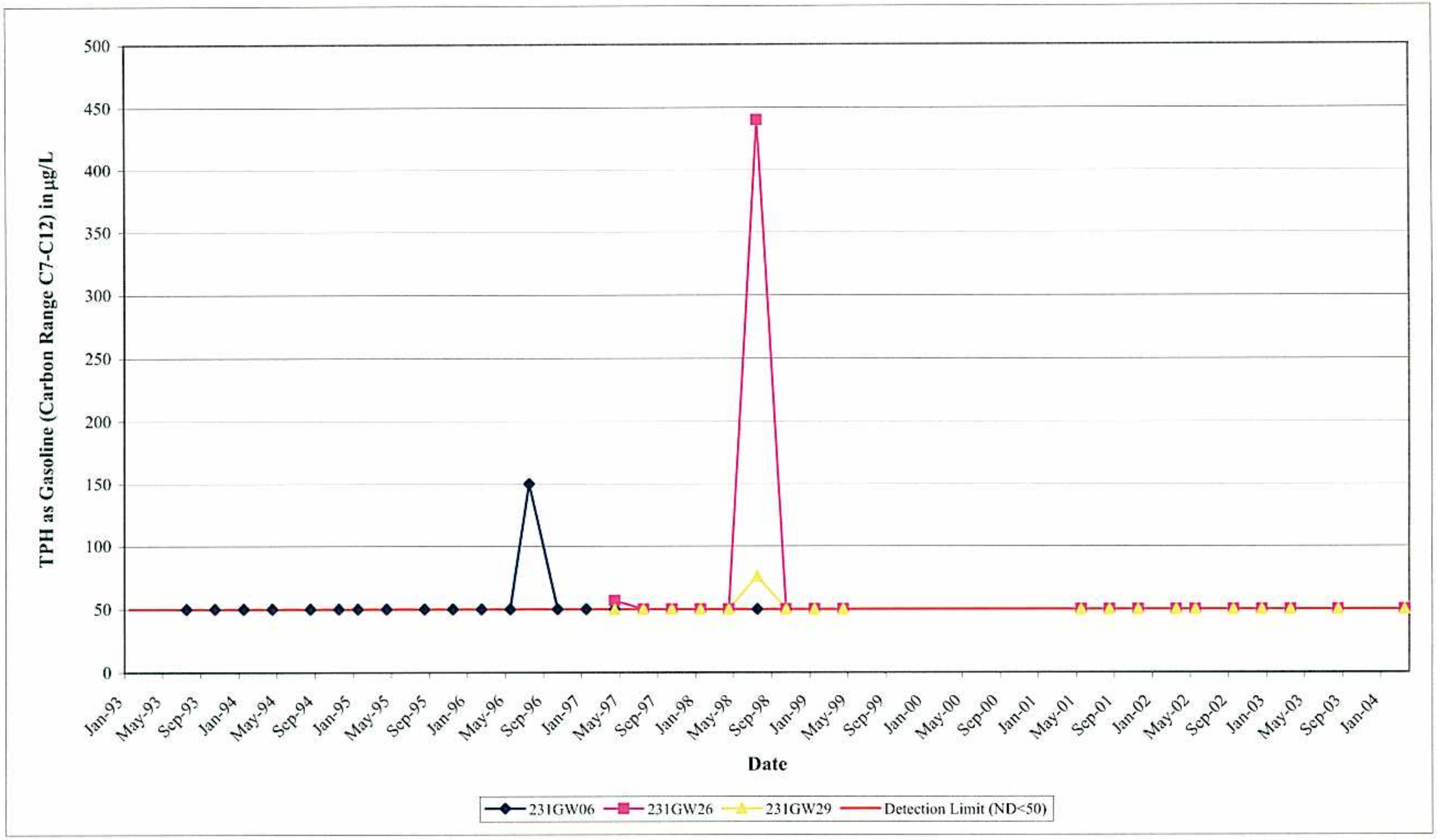


MACTEC

Historic Concentrations of TPH as Diesel in Groundwater
Shallow Sand Aquifer
Corrective Action Plan Building 207/231
Presidio of San Francisco, San Francisco, California

PLATE
14

DRAWN BY	JOB NUMBER	Checked	Approved	Date	Revised Date
NAM	4089041001 106	AM	MAJ	7/05	

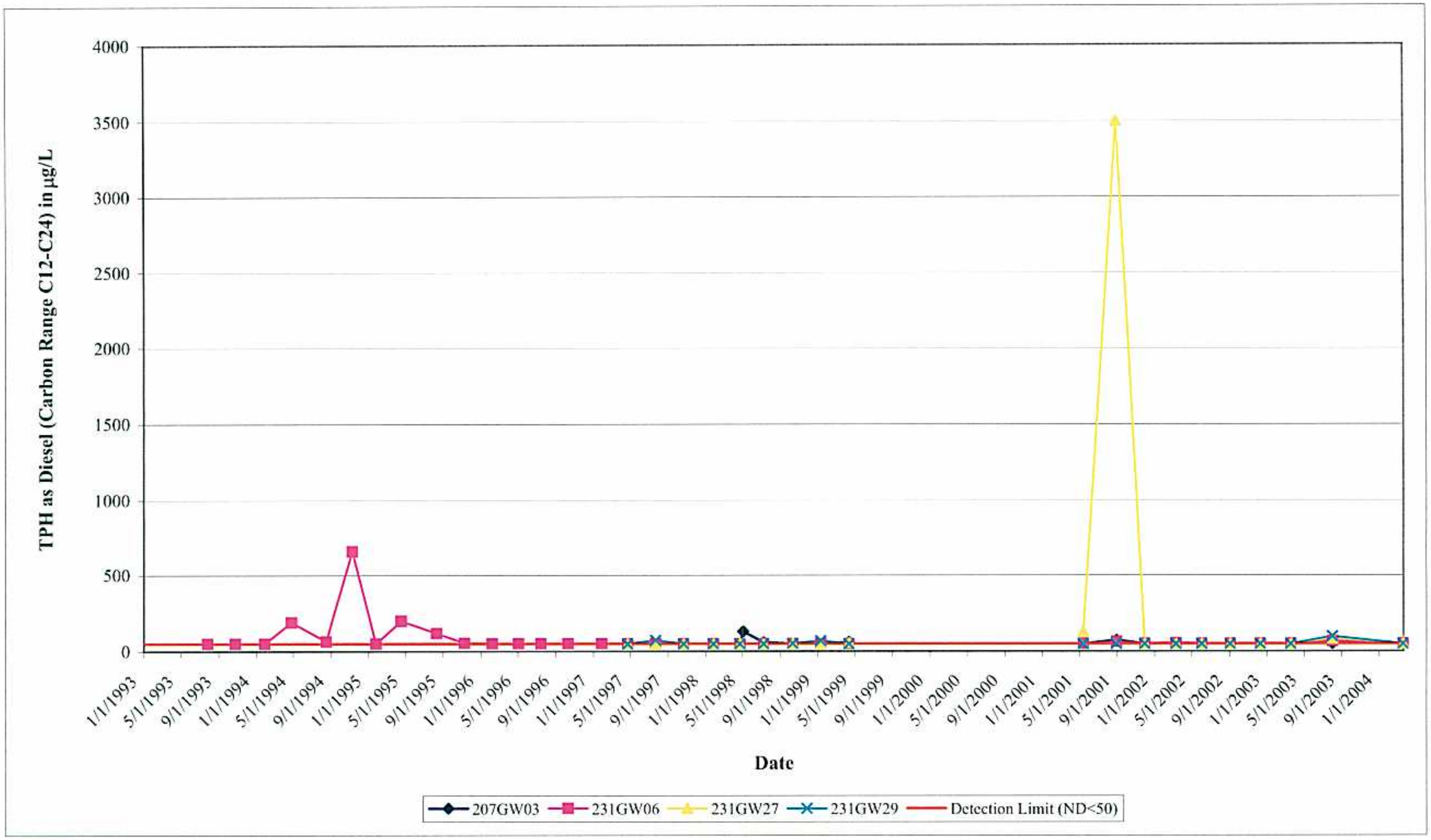


MACTEC

Historic Concentrations of TPH as Gasoline in Groundwater
Intermediate Sand Aquifer
Corrective Action Plan Building 207/231
Presidio of San Francisco, San Francisco, California

PLATE
15

DRAWN BY	JOB NUMBER	Checked	Approved	Date	Revised Date
NAM	4089041001 106	JM	MAJ	7/05	

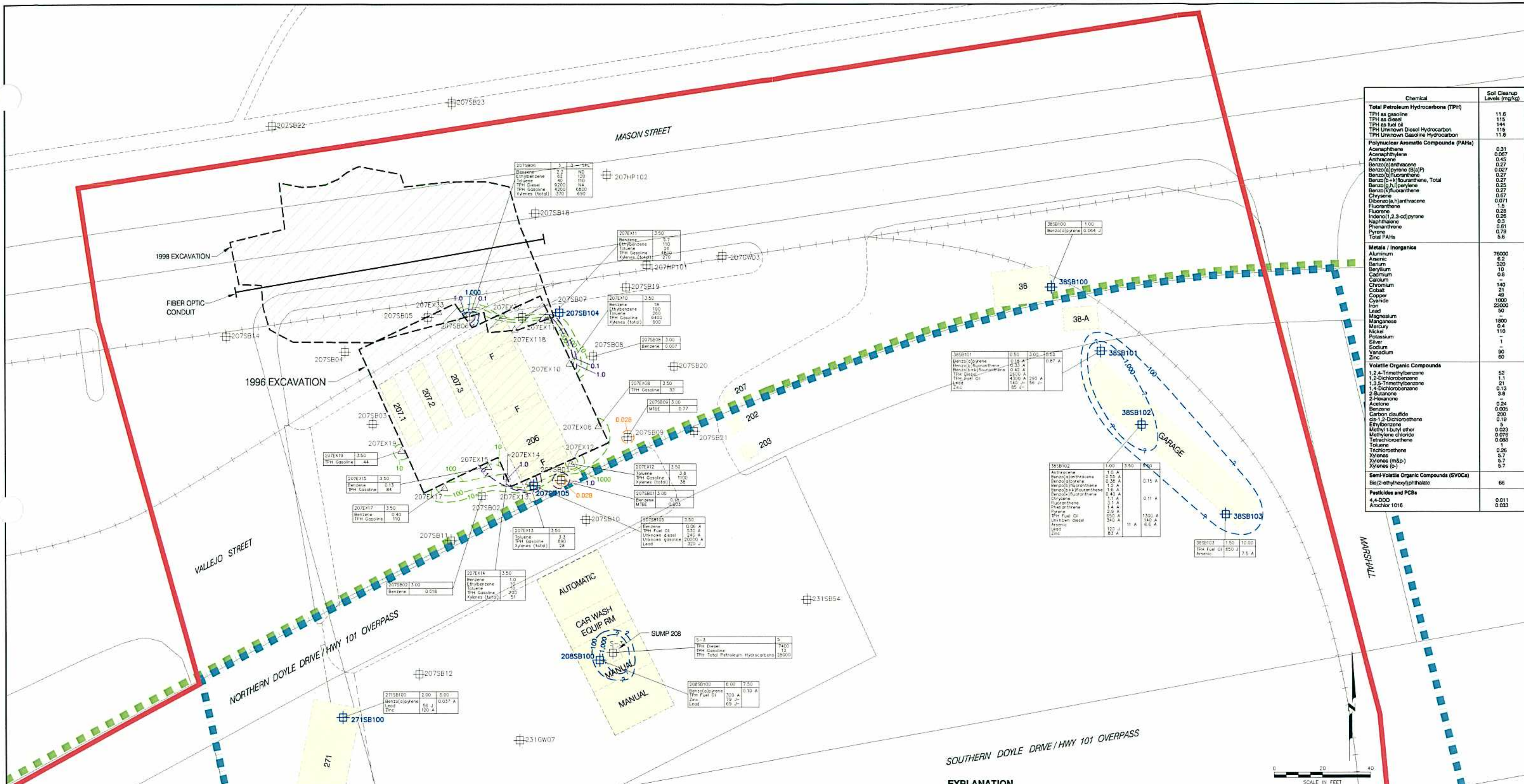


MACTEC

Historic Concentrations of TPH as Diesel in Groundwater
Intermediate Sand Aquifer
Corrective Action Plan Building 207/231
Presidio of San Francisco, San Francisco, California

PLATE
16

DRAWN BY	JOB NUMBER	Checked	Approved	Date	Revised Date
NAM	4089041001 106	AMC	MAJ	7/05	



Chemical	Soil Cleanup Levels (mg/kg)
Total Petroleum Hydrocarbons (TPH)	
TPH as gasoline	11.6
TPH as diesel	115
TPH as fuel oil	144
TPH Unknown Diesel Hydrocarbon	115
TPH Unknown Gasoline Hydrocarbon	11.6
Polynuclear Aromatic Compounds (PAHs)	
Acenaphthene	0.31
Acenaphthylene	0.067
Anthracene	0.45
Benzo(a)anthracene	0.27
Benzo(a)pyrene (B[a]P)	0.027
Benzo(b)fluoranthene	0.27
Benzo(b+k)flouranthene, Total	0.27
Benzo(g,h,i)perylene	0.25
Benzo(k)fluoranthene	0.27
Chrysene	0.67
Dibenzo(a,h)anthracene	0.071
Fluoranthene	1.5
Fluorene	0.28
Indeno(1,2,3-cd)pyrene	0.26
Naphthalene	0.3
Phenanthrene	0.61
Pyrene	0.79
Total PAHs	5.6
Metals / Inorganics	
Aluminum	76000
Arsenic	6.2
Barium	320
Beryllium	10
Cadmium	0.8
Calcium	–
Chromium	140
Cobalt	21
Copper	49
Cyanide	1000
Iron	23000
Lead	50
Magnesium	–
Manganese	1800
Mercury	0.4
Nickel	110
Potassium	–
Silver	1
Sodium	–
Vanadium	90
Zinc	60
Volatile Organic Compounds	
1,2,4-Trimethylbenzene	52
1,2-Dichlorobenzene	1.1
1,3,5-Trimethylbenzene	21
1,4-Dichlorobenzene	0.13
2-Butanone	3.8
2-Hexanone	–
Acetone	0.24
Benzene	0.005
Carbon disulfide	200
cis-1,2-Dichloroethene	0.19
Ethylbenzene	5
Methyl t-butyl ether	0.023
Methylene chloride	0.076
Tetrachloroethene	0.088
Toluene	1
Trichloroethene	0.26
Xylenes	5.7
Xylenes (m&p-)	5.7
Xylenes (o-)	5.7
Semi-Volatile Organic Compounds (SVOCs)	
Bis(2-ethylhexyl)phthalate	66
Pesticides and PCBs	
4,4-DDD	0.011
Arochlor 1016	0.033

EXPLANATION

- SOIL BORING LOCATION
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA BOUNDARY
- SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- FORMER FUEL ISLAND
- FORMER RAILROAD TRACKS
- PREVIOUS SOIL EXCAVATION AREA
- 1,000 TPH DIESEL AND/OR FUEL OIL CONCENTRATION CONTOUR (mg/kg)
- 100 GASOLINE CONCENTRATION CONTOUR (mg/kg)
- 1 BENZENE CONCENTRATION CONTOUR (mg/kg)
- 0.028 MTBE CONCENTRATION CONTOUR (mg/kg)

207SB02	3
Benzene	0.018

STATION
DEPTH IN FEET
ALL CONCENTRATIONS IN MILLIGRAMS PER KILOGRAM (mg/kg)
ANALYTE
- SPL = Split

NOTES:

1. THIS REPRESENTS ONE INTERPRETATION OF A LIMITED DATA SET; OTHER INTERPRETATIONS ARE POSSIBLE.
2. ONLY RESULTS THAT EXCEED CLEANUP LEVELS ARE SHOWN.
3. QUALIFIERS ARE ALWAYS LISTED AS VALIDATION QUALIFIER / LAB QUALIFIERS (i.e. J-, A).

J THE ANALYTE WAS POSITIVELY IDENTIFIED; THE ASSOCIATED NUMERICAL VALUE IS THE APPROXIMATE CONCENTRATION OF THE ANALYTE IN THE SAMPLE.

J+ THE ANALYTE WAS POSITIVELY IDENTIFIED; THE ASSOCIATED NUMERICAL VALUE IS BIASED LOW AND SHOULD BE CONSIDERED AN APPROXIMATE CONCENTRATION OF THE ANALYTE IN THE SAMPLE.

J- THE ANALYTE WAS POSITIVELY IDENTIFIED; THE ASSOCIATED NUMERICAL VALUE IS BIASED HIGH AND SHOULD BE CONSIDERED AN APPROXIMATE CONCENTRATION OF THE ANALYTE IN THE SAMPLE.

f SAMPLES FOR METALS ANALYSES FILTERED BY LABORATORY.

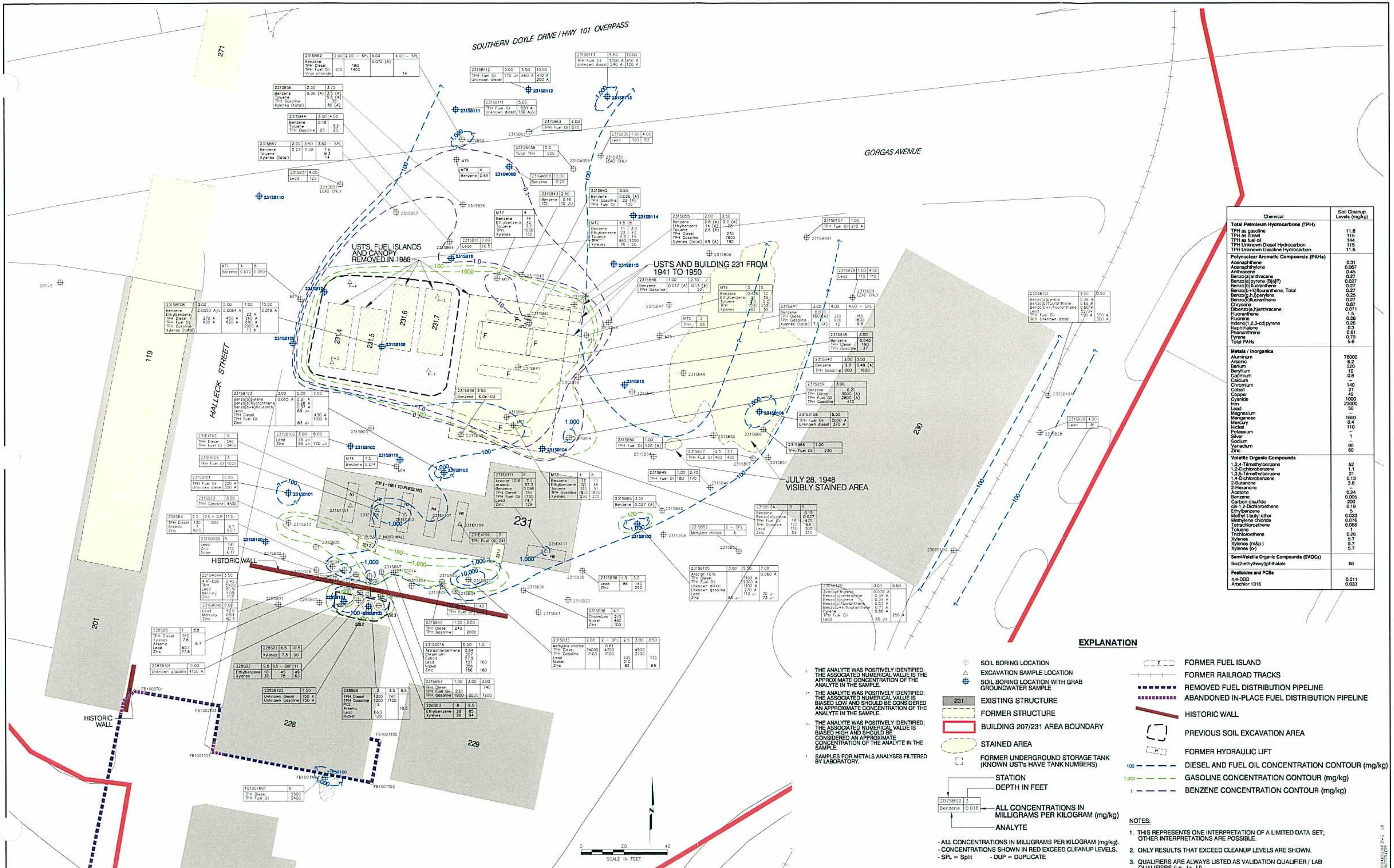
NO.	DATE	REVISIONS	BY	CHK	DRAWN: PCB	PROJECT NO. 4089041001 106
					ENGINEER: NAM	SCALE: AS SHOWN
					CHECKED:	APPROVED:
					DATE:	DATE:

MACTEC

Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Organic Compounds and Metals Detected in Soil Samples Exceeding Cleanup Levels Building 207 Area

PLATE: **17a**



Chemical	Soil Cleanup Levels (mg/kg)
Total Petroleum Hydrocarbons (TPH)	
TPH as gasoline	11.6
TPH as diesel	115
TPH as fuel oil	144
TPH Unknown Diesel Hydrocarbon	115
TPH Unknown Gasoline Hydrocarbon	11.6
Polynuclear Aromatic Compounds (PAHs)	
Acenaphthene	0.31
Acenaphthylene	0.067
Anthracene	0.45
Benzo(a)anthracene	0.27
Benzo(a)pyrene (B[a]P)	0.027
Benzo(b)fluoranthene	0.27
Benzo(b+k)flouranthene, Total	0.27
Benzo(g,h,i)perylene	0.25
Benzo(k)fluoranthene	0.27
Chrysene	0.67
Dibenzo(a,h)anthracene	0.071
Fluoranthene	1.5
Fluorene	0.28
Indeno(1,2,3-cd)pyrene	0.26
Naphthalene	0.3
Phenanthrene	0.61
Pyrene	0.79
Total PAHs	5.6
Metals / Inorganics	
Aluminum	76000
Arsenic	6.2
Barium	320
Beryllium	10
Cadmium	0.8
Calcium	–
Chromium	140
Cobalt	21
Copper	49
Cyanide	1000
Iron	23000
Lead	50
Magnesium	–
Manganese	1800
Mercury	0.4
Nickel	110
Potassium	–
Silver	1
Sodium	–
Vanadium	90
Zinc	60
Volatile Organic Compounds	
1,2,4-Trimethylbenzene	52
1,2-Dichlorobenzene	1.1
1,3,5-Trimethylbenzene	21
1,4-Dichlorobenzene	0.13
2-Butanone	3.8
2-Hexanone	–
Acetone	0.24
Benzene	0.005
Carbon disulfide	200
cis-1,2-Dichloroethene	0.19
Ethylbenzene	5
Methyl t-butyl ether	0.023
Methylene chloride	0.076
Tetrachloroethene	0.088
Toluene	1
Trichloroethene	0.26
Xylenes	5.7
Xylenes (m&p-)	5.7
Xylenes (o-)	5.7
Semi-Volatile Organic Compounds (SVOCs)	
Bis(2-ethylhexyl)phthalate	66
Pesticides and PCBs	
4,4-DDD	0.011
Arochlor 1016	0.033

EXPLANATION

J THE ANALYTE WAS POSITIVELY IDENTIFIED; THE ASSOCIATED NUMERICAL VALUE IS THE APPROXIMATE CONCENTRATION OF THE ANALYTE IN THE SAMPLE.

J+ THE ANALYTE WAS POSITIVELY IDENTIFIED; THE ASSOCIATED NUMERICAL VALUE IS BIASED LOW AND SHOULD BE CONSIDERED AN APPROXIMATE CONCENTRATION OF THE ANALYTE IN THE SAMPLE.

J- THE ANALYTE WAS POSITIVELY IDENTIFIED; THE ASSOCIATED NUMERICAL VALUE IS BIASED HIGH AND SHOULD BE CONSIDERED AN APPROXIMATE CONCENTRATION OF THE ANALYTE IN THE SAMPLE.

F SAMPLES FOR METALS ANALYSES FILTERED BY LABORATORY.

- SOIL BORING LOCATION
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- 231 EXISTING STRUCTURE
- FORMER STRUCTURE
- BUILDING 207/231 AREA BOUNDARY
- STAINED AREA
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- FORMER FUEL ISLAND
- FORMER RAILROAD TRACKS
- REMOVED FUEL DISTRIBUTION PIPELINE
- ABANDONED IN-PLACE FUEL DISTRIBUTION PIPELINE
- HISTORIC WALL
- PREVIOUS SOIL EXCAVATION AREA
- FORMER HYDRAULIC LIFT
- 100 DIESEL AND FUEL OIL CONCENTRATION CONTOUR (mg/kg)
- 1,000 GASOLINE CONCENTRATION CONTOUR (mg/kg)
- 1 BENZENE CONCENTRATION CONTOUR (mg/kg)

207SB02	3
Benzene	0.018

STATION

DEPTH IN FEET

ALL CONCENTRATIONS IN MILLIGRAMS PER KILOGRAM (mg/kg)

ANALYTE

- ALL CONCENTRATIONS IN MILLIGRAMS PER KILOGRAM (mg/kg).
- CONCENTRATIONS SHOWN IN RED EXCEED CLEANUP LEVELS.
- SPL = Split - DUP = DUPLICATE

NOTES:

1. THIS REPRESENTS ONE INTERPRETATION OF A LIMITED DATA SET; OTHER INTERPRETATIONS ARE POSSIBLE.
2. ONLY RESULTS THAT EXCEED CLEANUP LEVELS ARE SHOWN.
3. QUALIFIERS ARE ALWAYS LISTED AS VALIDATION QUALIFIER / LAB QUALIFIERS (i.e. J+, U).

NO.	DATE	REVISIONS	BY	CHK

DRAWN:	CN	PROJECT NO:	4089041001 106
ENGINEER:	NAM	SCALE:	AS SHOWN
CHECKED:		APPROVED:	
DATE:		DATE:	

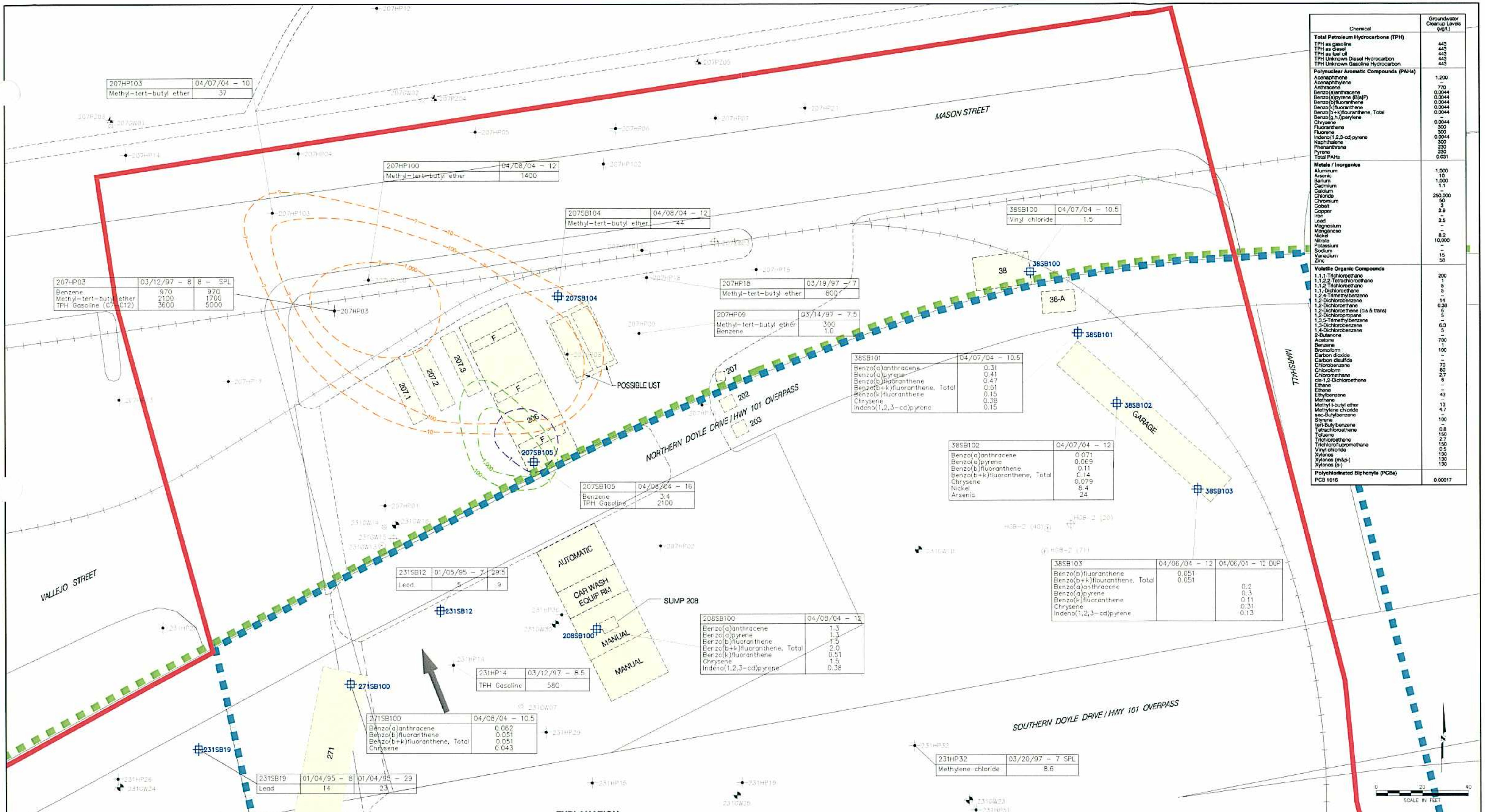
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Organic Compounds and Metals in Soil Samples Exceeding Cleanup Levels
Building 231 Area

PLATE:
17b



Chemical	Groundwater Cleanup Levels (µg/L)
Total Petroleum Hydrocarbons (TPH)	
TPH as gasoline	443
TPH as diesel	443
TPH as fuel oil	443
TPH Unknown Diesel Hydrocarbon	443
TPH Unknown Gasoline Hydrocarbon	443
Polynuclear Aromatic Compounds (PAHs)	
Acenaphthene	1,200
Acenaphthylene	–
Anthracene	770
Benzo(a)anthracene	0.0044
Benzo(a)pyrene (B[a]P)	0.0044
Benzo(b)fluoranthene	0.0044
Benzo(k)fluoranthene	0.0044
Benzo(b+k)flouranthene, Total	0.0044
Benzo(g,h,i)perylene	–
Chrysene	0.0044
Fluoranthene	300
Fluorene	300
Indeno(1,2,3-cd)pyrene	0.0044
Naphthalene	300
Phenanthrene	230
Pyrene	230
Total PAHs	0.031
Metals / Inorganics	
Aluminum	1,000
Arsenic	10
Barium	1,000
Cadmium	1.1
Calcium	–
Chloride	250,000
Chromium	50
Cobalt	3
Copper	2.9
Iron	–
Lead	2.5
Magnesium	–
Manganese	–
Nickel	8.2
Nitrate	10,000
Potassium	–
Sodium	–
Vanadium	15
Zinc	58
Volatile Organic Compounds	
1,1,1-Trichloroethane	200
1,1,2,2-Tetrachloroethane	1
1,1,2-Trichloroethane	5
1,1,-Dichloroethane	5
1,2,4-Trimethylbenzene	–
1,2-Dichlorobenzene	14
1,2-Dichloroethane	0.38
1,2-Dichloroethene (cis & trans)	6
1,2-Dichloropropane	5
1,3,5-Trimethylbenzene	–
1,3-Dichlorobenzene	6.3
1,4-Dichlorobenzene	5
2-Butanone	–
Acetone	700
Benzene	1
Bromoform	100
Carbon dioxide	–
Carbon disulfide	–
Chlorobenzene	70
Chloroform	80
Chloromethane	2.7
cis-1,2-Dichloroethene	6
Ethane	–
Ethene	–
Ethylbenzene	43
Methane	–
Methyl t-butyl ether	13
Methylene chloride	4.7
sec-Butylbenzene	–
Styrene	100
tert-Butylbenzene	–
Tetrachloroethene	0.8
Toluene	150
Trichloroethene	2.7
Trichlorofluoromethane	150
Vinyl chloride	0.5
Xylenes	130
Xylenes (m&p-)	130
Xylenes (o-)	130
Polychlorinated Biphenyls (PCBs)	
PCB 1016	0.00017

EXPLANATION

- MONITORING WELL - SHALLOW SAND
- MONITORING WELL - UPPER INTERMEDIATE SAND
- MONITORING WELL - LOWER INTERMEDIATE SAND
- MONITORING WELL - DECOMMISSIONED
- PIEZOMETER - DECOMMISSIONED
- HYDROPUNCH
- SOIL BORING LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA BOUNDARY
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- FORMER FUEL ISLAND
- FORMER RAILROAD TRACKS
- APPROXIMATE DIRECTION OF SHALLOW ZONE GROUNDWATER FLOW MAY 24, 2004
- 1,000 MTBE CONCENTRATION CONTOUR (µg/L)
- 100 BENZENE CONCENTRATION CONTOUR (µg/L)
- 100 GASOLINE CONCENTRATION CONTOUR (µg/L)

STATION NAME / SAMPLE DATE / SAMPLE DEPTH (FEET BGS) / CONCENTRATION µg/L / ANALYTE

38SB103 4/06/04 - 12 Nickel 7.4

- ALL RESULTS IN MICROGRAMS PER LITER (µg/L)
- SPL = Split - DUP = DUPLICATE

NOTES:

1. THIS REPRESENTS ONE INTERPRETATION OF A LIMITED DATA SET; OTHER INTERPRETATIONS ARE POSSIBLE.
2. ONLY RESULTS THAT EXCEED CLEANUP LEVELS FOR BOTH PREVIOUSLY COLLECTED SAMPLES AND SAMPLES FROM THE DATA GAPS INVESTIGATION LEVELS ARE SHOWN.
3. CONTOURS ARE BASED ON THE 5 MOST CURRENT YEARS OF DATA. DATA PRIOR TO 5 YEARS IS POSTED, BUT WAS NOT CONTOURED.

NO.	DATE	REVISIONS	BY	CHK

DRAWN: CN | ENGINEER: NAM | CHECKED: | DATE: 07/05

PROJECT NO: 4089041001 106 | SCALE: AS SHOWN | APPROVED: | DATE: 07/05

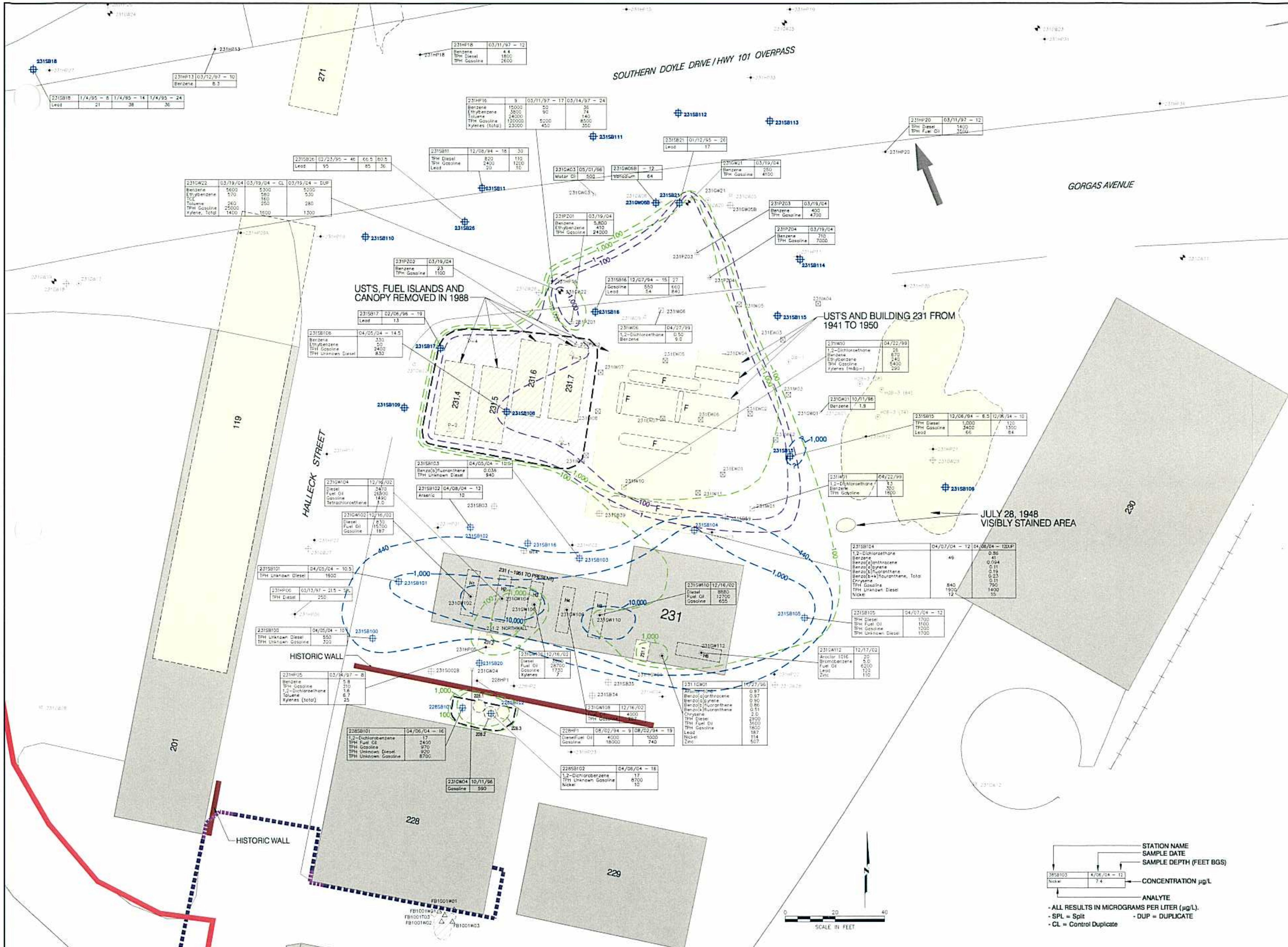
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Organic Compounds and Metals Detected in Groundwater Exceeding Cleanup Levels Building 207 Area

PLATE: 18a



Chemical	Groundwater Cleanup Levels (µg/L)
Total Petroleum Hydrocarbons (TPH)	
TPH as gasoline	443
TPH as diesel	443
TPH as fuel oil	443
TPH Unknown Diesel Hydrocarbon	443
TPH Unknown Gasoline Hydrocarbon	443
Polynuclear Aromatic Compounds (PAHs)	
Acenaphthene	1,200
Acenaphthylene	–
Anthracene	770
Benzo(a)anthracene	0.0044
Benzo(a)pyrene (B[a]P)	0.0044
Benzo(b)fluoranthene	0.0044
Benzo(k)fluoranthene	0.0044
Benzo(b+k)flouranthene, Total	0.0044
Benzo(g,h,i)perylene	–
Chrysene	0.0044
Fluoranthene	300
Fluorene	300
Indeno(1,2,3-cd)pyrene	0.0044
Naphthalene	300
Phenanthrene	230
Pyrene	230
Total PAHs	0.031
Metals / Inorganics	
Aluminum	1,000
Arsenic	10
Barium	1,000
Cadmium	1.1
Calcium	–
Chloride	250,000
Chromium	50
Cobalt	3
Copper	2.9
Iron	–
Lead	2.5
Magnesium	–
Manganese	–
Nickel	8.2
Nitrate	10,000
Potassium	–
Sodium	–
Vanadium	15
Zinc	58
Volatile Organic Compounds	
1,1,1-Trichloroethane	200
1,1,2,2-Tetrachloroethane	1
1,1,2-Trichloroethane	5
1,1,-Dichloroethane	5
1,2,4-Trimethylbenzene	–
1,2-Dichlorobenzene	14
1,2-Dichloroethane	0.38
1,2-Dichloroethene (cis & trans)	6
1,2-Dichloropropane	5
1,3,5-Trimethylbenzene	–
1,3-Dichlorobenzene	6.3
1,4-Dichlorobenzene	5
2-Butanone	–
Acetone	700
Benzene	1
Bromoform	100
Carbon dioxide	–
Carbon disulfide	–
Chlorobenzene	70
Chloroform	80
Chloromethane	2.7
cis-1,2-Dichloroethene	6
Ethane	–
Ethene	–
Ethylbenzene	43
Methane	–
Methyl t-butyl ether	13
Methylene chloride	4.7
sec-Butylbenzene	–
Styrene	100
tert-Butylbenzene	–
Tetrachloroethene	0.8
Toluene	150
Trichloroethene	2.7
Trichlorofluoromethane	150
Vinyl chloride	0.5
Xylenes	130
Xylenes (m&p-)	130
Xylenes (o-)	130
Polychlorinated Biphenyls (PCBs)	
PCB 1016	0.00017

EXPLANATION

- MONITORING WELL - SHALLOW ZONE
- MONITORING WELL - INTERMEDIATE ZONES
- MONITORING WELL - DEEP ZONES
- MONITORING WELL - DECOMMISSIONED
- HYDROPUNCH
- GRAB GROUNDWATER SAMPLE
- SOIL BORING LOCATION
- PIEZOMETER - SHALLOW SAND
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- SVE AND GROUNDWATER INJECTION (IW) OR EXTRACTION (EW) WELL
- FORMER FUEL ISLAND
- FORMER RAILROAD TRACKS
- REMOVED FUEL DISTRIBUTION PIPELINE
- ABANDONED IN-PLACE FUEL DISTRIBUTION PIPELINE
- HISTORIC WALL
- PREVIOUS SOIL EXCAVATION AREA
- FORMER HYDRAULIC LIFT
- 1,000 DIESEL AND/OR FUEL OIL CONCENTRATION CONTOUR (µg/L)
- 1,000 GASOLINE CONCENTRATION CONTOUR (µg/L)
- 1 BENZENE CONCENTRATION CONTOUR (µg/L)
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE
- BUILDING 207/231 AREA BOUNDARY
- STAINED AREA
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- APPROXIMATE DIRECTION OF SHALLOW ZONE GROUNDWATER FLOW MAY 24, 2004

STATION NAME
SAMPLE DATE
SAMPLE DEPTH (FEET BGS)

2315B103	4/06/04 - 12
Nickel	7.4

CONCENTRATION µg/L
ANALYTE

- ALL RESULTS IN MICROGRAMS PER LITER (µg/L).
- SPL = Split
- DUP = DUPLICATE
- CL = Control Duplicate

NOTES:

1. THIS REPRESENTS ONE INTERPRETATION OF A LIMITED DATA SET; OTHER INTERPRETATIONS ARE POSSIBLE.
2. ONLY RESULTS THAT EXCEED CLEANUP LEVELS ARE SHOWN.
3. CONTOURS ARE BASED ON THE 5 MOST RECENT YEARS OF DATA. DATA PRIOR TO 5 YEARS IS POSTED, BUT NOT CONTOURED.

NO.	DATE	REVISIONS	BY	CHK	DRAWN: CN	PROJECT NO: 4089041001 106
					ENGINEER: NAM	SCALE: AS SHOWN
					CHECKED:	APPROVED:
					DATE:	DATE:

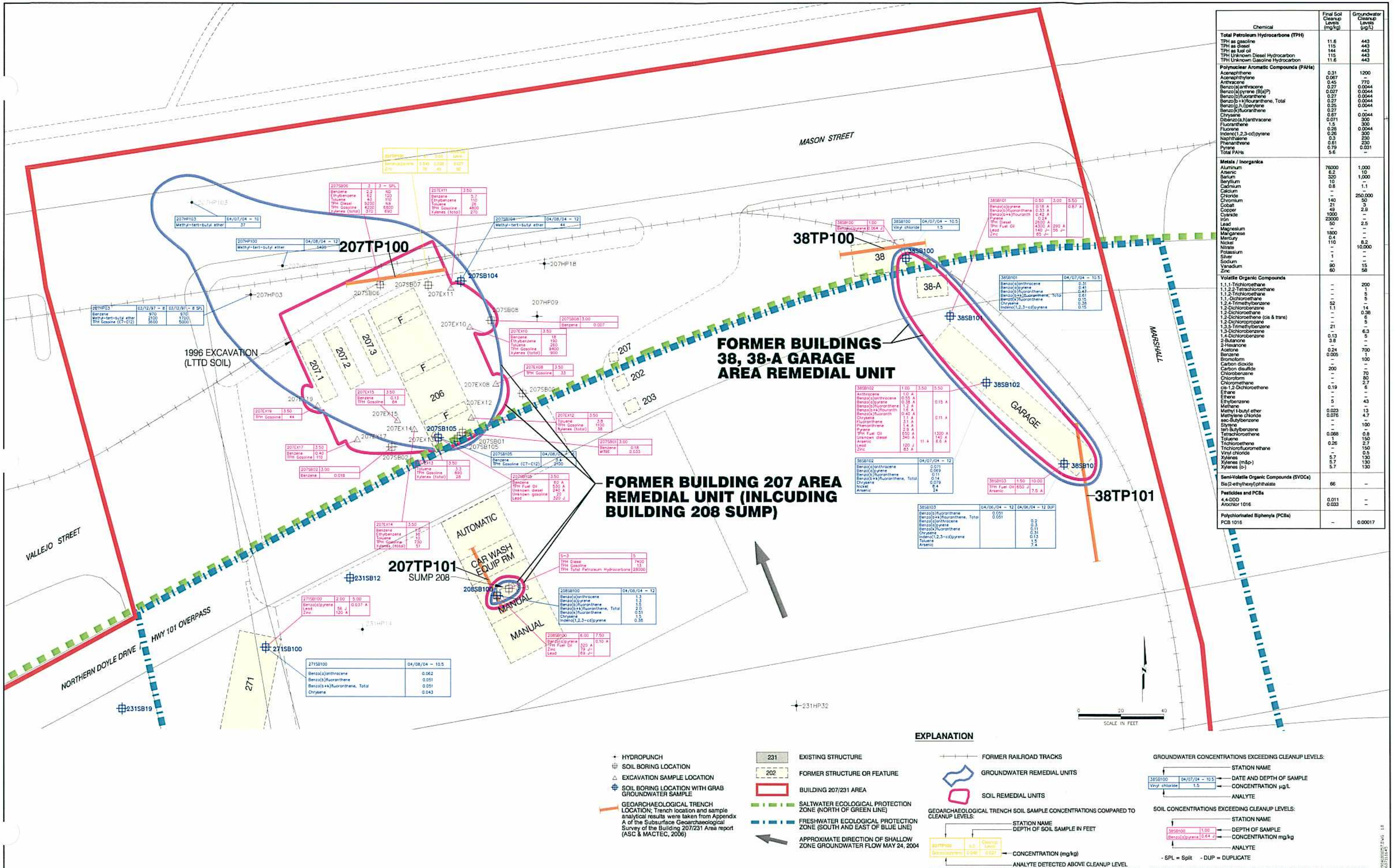
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Organic Compounds and Metals In Groundwater Samples Exceeding Cleanup Levels Building 231 Area

PLATE: **18b**



Chemical	Final Soil Cleanup Levels (mg/kg)	Groundwater Cleanup Levels (µg/L)
Total Petroleum Hydrocarbons (TPH)		
TPH as gasoline	11.6	443
TPH as diesel	115	443
TPH as fuel oil	144	443
TPH Unknown Diesel Hydrocarbon	115	443
TPH Unknown Gasoline Hydrocarbon	11.6	443
Polynuclear Aromatic Compounds (PAHs)		
Acenaphthene	0.31	1200
Acenaphthylene	0.067	–
Anthracene	0.45	770
Benzo(a)anthracene	0.27	0.0044
Benzo(a)pyrene (B[a]P)	0.027	0.0044
Benzo(b)fluoranthene	0.27	0.0044
Benzo(b+k)flouranthene, Total	0.27	0.0044
Benzo(g,h,i)perylene	0.25	0.0044
Benzo(k)fluoranthene	0.27	–
Chrysene	0.67	0.0044
Dibenzo(a,h)anthracene	0.071	300
Fluoranthene	1.5	300
Fluorene	0.28	0.0044
Indeno(1,2,3-cd)pyrene	0.26	300
Naphthalene	0.3	230
Phenanthrene	0.61	230
Pyrene	0.79	0.031
Total PAHs	5.6	–
Metals / Inorganics		
Aluminum	76000	1,000
Arsenic	6.2	10
Barium	320	1,000
Beryllium	10	–
Cadmium	0.8	1.1
Calcium	–	–
Chloride	–	250,000
Chromium	140	50
Cobalt	21	3
Copper	49	2.9
Cyanide	1000	–
Iron	23000	–
Lead	50	2.5
Magnesium	–	–
Manganese	1800	–
Mercury	0.4	–
Nickel	110	8.2
Nitrate	–	10,000
Potassium	–	–
Silver	1	–
Sodium	–	–
Vanadium	90	15
Zinc	60	58
Volatile Organic Compounds		
1,1,1-Trichloroethane	–	200
1,1,2,2-Tetrachloroethane	–	1
1,1,2-Trichloroethane	–	5
1,1,-Dichloroethane	–	5
1,2,4-Trimethylbenzene	52	–
1,2-Dichlorobenzene	1.1	14
1,2-Dichloroethane	–	0.38
1,2-Dichloroethene (cis & trans)	–	6
1,2-Dichloropropane	–	5
1,3,5-Trimethylbenzene	21	–
1,3-Dichlorobenzene	–	6.3
1,4-Dichlorobenzene	0.13	5
2-Butanone	3.8	–
2-Hexanone	–	–
Acetone	0.24	700
Benzene	0.005	1
Bromoform	–	100
Carbon dioxide	–	–
Carbon disulfide	200	–
Chlorobenzene	–	70
Chloroform	–	80
Chloromethane	–	2.7
cis-1,2-Dichloroethene	0.19	6
Ethane	–	–
Ethene	–	–
Ethylbenzene	5	43
Methane	–	–
Methyl t-butyl ether	0.023	13
Methylene chloride	0.076	4.7
sec-Butylbenzene	–	–
Styrene	–	100
tert-Butylbenzene	–	–
Tetrachloroethene	0.088	0.8
Toluene	1	150
Trichloroethene	0.26	2.7
Trichlorofluoromethane	–	150
Vinyl chloride	–	0.5
Xylenes	5.7	130
Xylenes (m&p-)	5.7	130
Xylenes (o-)	5.7	130
Semi-Volatile Organic Compounds (SVOCs)		
Bis(2-ethylhexyl)phthalate	66	–
Pesticides and PCBs		
4,4-DDD	0.011	–
Arochlor 1016	0.033	–
Polychlorinated Biphenyls (PCBs)		
PCB 1016	–	0.00017

NO.	DATE	REVISIONS	BY	CHK

DRAWN: PH
ENGINEER: NAM
CHECKED:
DATE:
PROJECT NO: 4089041001 106
SCALE: AS SHOWN
APPROVED:
DATE:

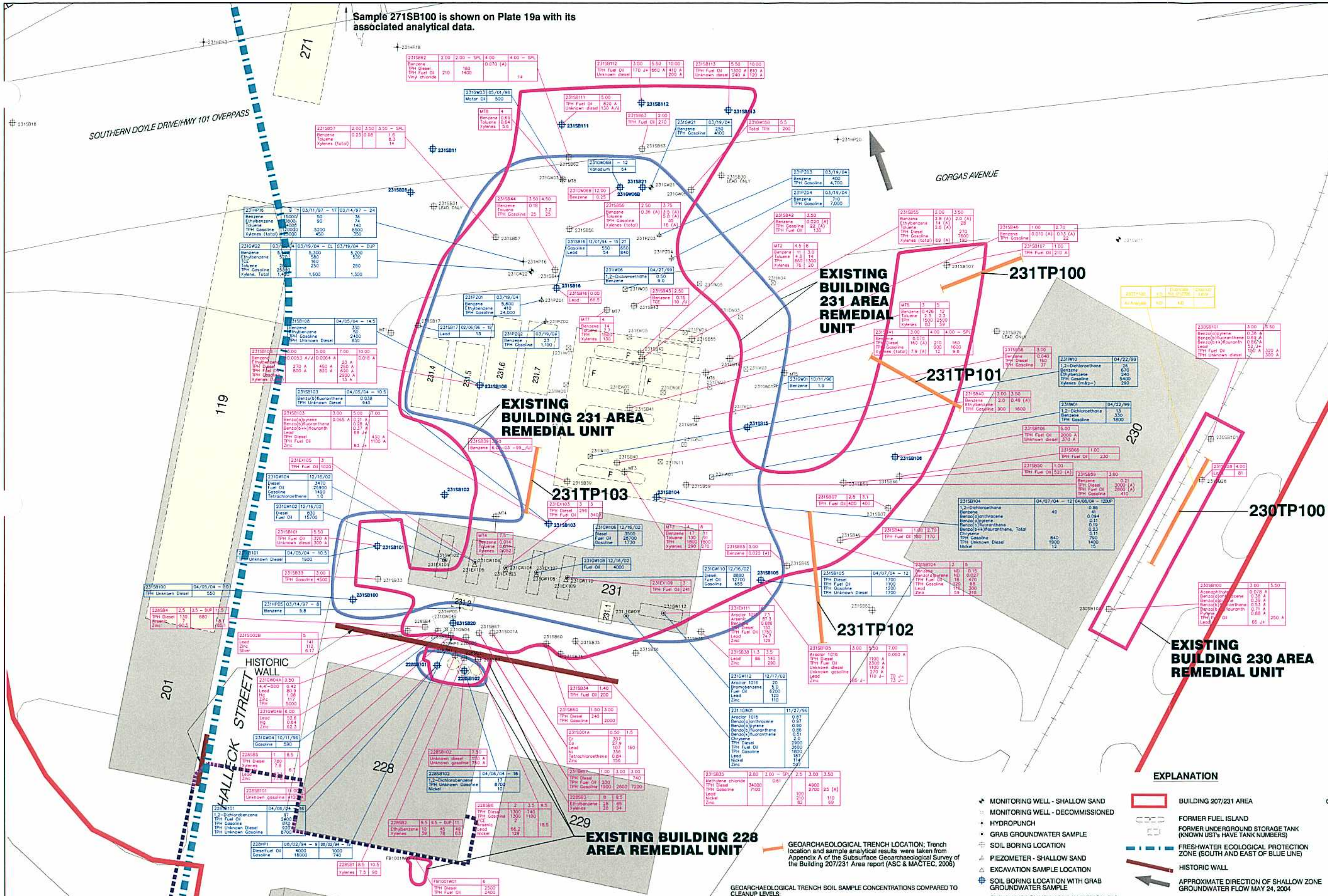
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Soil and Groundwater Remedial Units
Building 207 Area

PLATE: **19a**



Chemical	Final Soil Cleanup Levels (mg/kg)	Groundwater Cleanup Levels (µg/L)
Total Petroleum Hydrocarbons (TPH)		
TPH as gasoline	11.6	443
TPH as diesel	115	443
TPH as fuel oil	144	443
TPH Unknown Diesel Hydrocarbon	115	443
TPH Unknown Gasoline Hydrocarbon	11.6	443
Polynuclear Aromatic Compounds (PAHs)		
Acenaphthene	0.31	1200
Acenaphthylene	0.067	–
Anthracene	0.45	770
Benzo(a)anthracene	0.27	0.0044
Benzo(a)pyrene (B[a]P)	0.027	0.0044
Benzo(b)fluoranthene	0.27	0.0044
Benzo(b+k)flouranthene, Total	0.27	0.0044
Benzo(g,h,i)perylene	0.25	0.0044
Benzo(k)fluoranthene	0.27	–
Chrysene	0.67	0.0044
Dibenzo(a,h)anthracene	0.071	300
Fluoranthene	1.5	300
Fluorene	0.28	0.0044
Indeno(1,2,3-cd)pyrene	0.26	300
Naphthalene	0.3	230
Phenanthrene	0.61	230
Pyrene	0.79	0.031
Total PAHs	5.6	–
Metals / Inorganics		
Aluminum	76000	1,000
Arsenic	6.2	10
Barium	320	1,000
Beryllium	10	–
Cadmium	0.8	1.1
Calcium	–	–
Chloride	–	250,000
Chromium	140	50
Cobalt	21	3
Copper	49	2.9
Cyanide	1000	–
Iron	23000	–
Lead	50	2.5
Magnesium	–	–
Manganese	1800	–
Mercury	0.4	–
Nickel	110	8.2
Nitrate	–	10,000
Potassium	–	–
Silver	1	–
Sodium	–	–
Vanadium	90	15
Zinc	60	58
Volatile Organic Compounds		
1,1,1-Trichloroethane	–	200
1,1,2,2-Tetrachloroethane	–	1
1,1,2-Trichloroethane	–	5
1,1,-Dichloroethane	–	5
1,2,4-Trimethylbenzene	52	–
1,2-Dichlorobenzene	1.1	14
1,2-Dichloroethane	–	0.38
1,2-Dichloroethene (cis & trans)	–	6
1,2-Dichloropropane	–	5
1,3,5-Trimethylbenzene	21	–
1,3-Dichlorobenzene	–	6.3
1,4-Dichlorobenzene	0.13	5
2-Butanone	3.8	–
2-Hexanone	–	–
Acetone	0.24	700
Benzene	0.005	1
Bromoform	–	100
Carbon dioxide	–	–
Carbon disulfide	200	–
Chlorobenzene	–	70
Chloroform	–	80
Chloromethane	–	2.7
cis-1,2-Dichloroethene	0.19	6
Ethane	–	–
Ethene	–	–
Ethylbenzene	5	43
Methane	–	–
Methyl t-butyl ether	0.023	13
Methylene chloride	0.076	4.7
sec-Butylbenzene	–	–
Styrene	–	100
tert-Butylbenzene	–	–
Tetrachloroethene	0.068	0.8
Toluene	1	150
Trichloroethene	0.26	2.7
Trichlorofluoromethane	–	150
Vinyl chloride	–	0.5
Xylenes	5.7	130
Xylenes (m&p-)	5.7	130
Xylenes (o-)	5.7	130
Semi-Volatile Organic Compounds (SVOCs)		
Bis(2-ethylhexyl)phthalate	66	–
Pesticides and PCBs		
4,4-DDD	0.011	–
Arochlor 1016	0.033	–
Polychlorinated Biphenyls (PCBs)		
PCB 1016	–	0.00017

0 20 40
SCALE IN FEET

EXPLANATION

- MONITORING WELL - SHALLOW SAND
- MONITORING WELL - DECOMMISSIONED
- HYDROPUNCH
- GRAB GROUNDWATER SAMPLE
- SOIL BORING LOCATION
- PIEZOMETER - SHALLOW SAND
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- SVE AND GROUNDWATER INJECTION (IW) OR EXTRACTION (EW) WELL
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA
- FORMER FUEL ISLAND
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- HISTORIC WALL
- APPROXIMATE DIRECTION OF SHALLOW ZONE GROUNDWATER FLOW MAY 24, 2004
- FORMER RAILROAD TRACKS
- GROUNDWATER REMEDIAL UNITS
- SOIL REMEDIAL UNITS

GEOARCHAEOLOGICAL TRENCH LOCATION; Trench location and sample analytical results were taken from Appendix A of the Subsurface Geoarchaeological Survey of the Building 207/231 Area report (ASC & MACTEC, 2006)

GEOARCHAEOLOGICAL TRENCH SOIL SAMPLE CONCENTRATIONS COMPARED TO CLEANUP LEVELS:

230TP100	4.0	Duplicate No. 012706	Cleanup Level
All Analytes	ND	ND	–

STATION NAME
DEPTH OF SOIL SAMPLE IN FEET
CONCENTRATION (mg/kg)
ANALYTE

GROUNDWATER CONCENTRATIONS EXCEEDING CLEANUP LEVELS:

228HP1	08/02/94 – 9
Diesel Fuel Oil	4000
Gasoline	18000

STATION NAME
DATE AND DEPTH OF SAMPLE
CONCENTRATION µg/L
ANALYTE

SOIL CONCENTRATIONS EXCEEDING CLEANUP LEVELS:

228SB102	7.50
Unknown diesel	150 A
Unknown gasoline	750 A

STATION NAME
DEPTH OF SAMPLE
CONCENTRATION mg/kg
ANALYTE

- SPL = Split - DUP = DUPLICATE

NOTE: ONLY RESULTS THAT WERE DETECTED ABOVE CLEANUP LEVELS ARE SHOWN.

NO.	DATE	REVISIONS	BY	CHK

DRAWN: PH
ENGINEER: NAM
CHECKED:
DATE:
PROJECT NO. 4089041001 106
SCALE: AS SHOWN
APPROVED:
DATE:

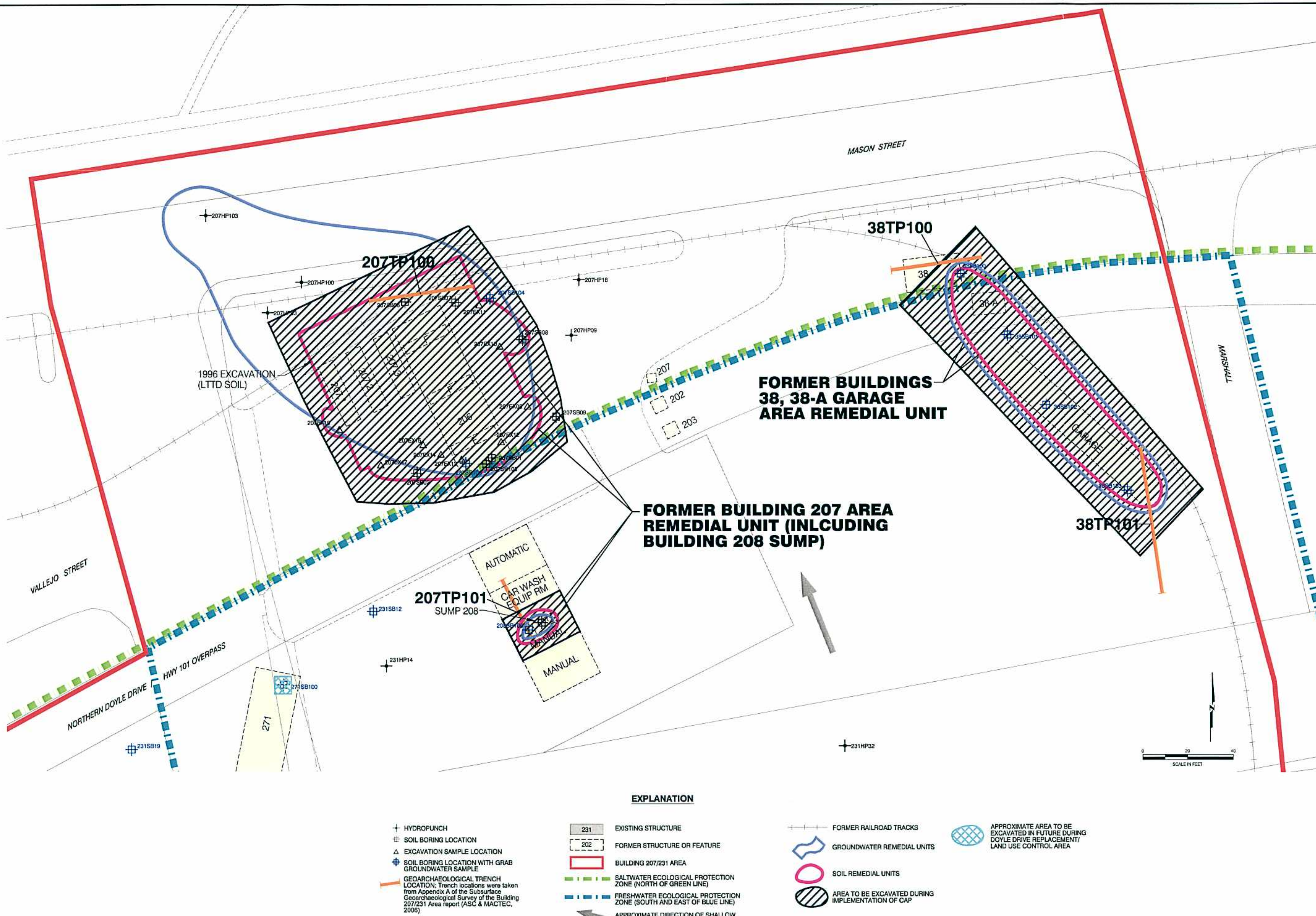
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Soil and Groundwater Remedial Units
Building 231 Area

PLATE: **19b**



NO	DATE	REVISIONS	BY	CHK

DRAWN: CN | ENGINEER: NAM | CHECKED: | DATE:

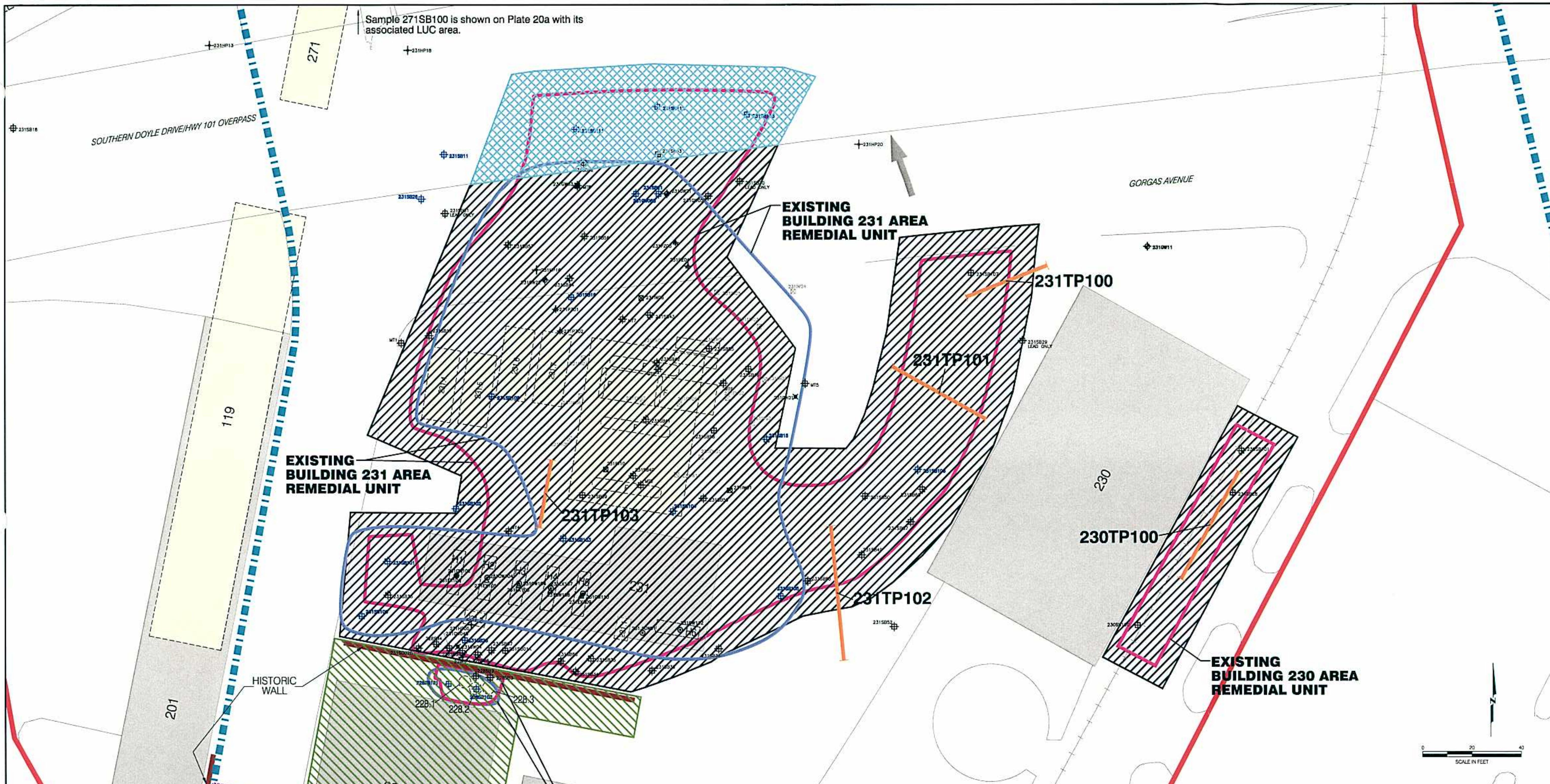
PROJECT NO: 4089041001 106 | SCALE: AS SHOWN | APPROVED: | DATE:

MACTEC

Corrective Action Plan
Building 207/231 Area
Presidio of San Francisco
San Francisco, California

Proposed Excavation Areas
Building 207 Area

PLATE: 20a



EXPLANATION

- MONITORING WELL - SHALLOW SAND
- MONITORING WELL - DECOMMISSIONED
- HYDROPUNCH
- GRAB GROUNDWATER SAMPLE
- SOIL BORING LOCATION
- PIEZOMETER - SHALLOW SAND
- EXCAVATION SAMPLE LOCATION
- SOIL BORING LOCATION WITH GRAB GROUNDWATER SAMPLE
- SVE AND GROUNDWATER INJECTION (IW) OR EXTRACTION (EW) WELL
- GEOARCHAEOLOGICAL TRENCH LOCATION; Trench location and sample analytical results were taken from Appendix A of the Subsurface Geoarchaeological Survey of the Building 207/231 Area report (ASC & MACTEC, 2006)
- 231 EXISTING STRUCTURE
- 202 FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA
- FORMER FUEL ISLAND
- FORMER UNDERGROUND STORAGE TANK (KNOWN UST's HAVE TANK NUMBERS)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- HISTORIC WALL
- APPROXIMATE DIRECTION OF SHALLOW ZONE GROUNDWATER FLOW MAY 24, 2004
- FORMER RAILROAD TRACKS
- GROUNDWATER REMEDIAL UNITS
- SOIL REMEDIAL UNITS
- APPROXIMATE LOCATION OF AREA TO BE EXCAVATED DURING IMPLEMENTATION OF CAP
- APPROXIMATE CAPPING/LAND USE CONTROL AREA
- APPROXIMATE AREA TO BE EXCAVATED IN FUTURE DURING DOYLE DRIVE REPLACEMENT/ LAND USE CONTROL AREA

230TP100	4.0	Duplicate No. 012706	Cleanup Level
All Analytes	ND	ND	–

STATION NAME; DEPTH OF SOIL SAMPLE IN FEET; CONCENTRATION (mg/kg); ANALYTE

NO	DATE	REVISIONS	BY	CHK	DRAWN: CN	PROJECT NO: 4089041001 106
					ENGINEER: NAM	SCALE: AS SHOWN
					CHECKED:	APPROVED:
					DATE:	DATE:

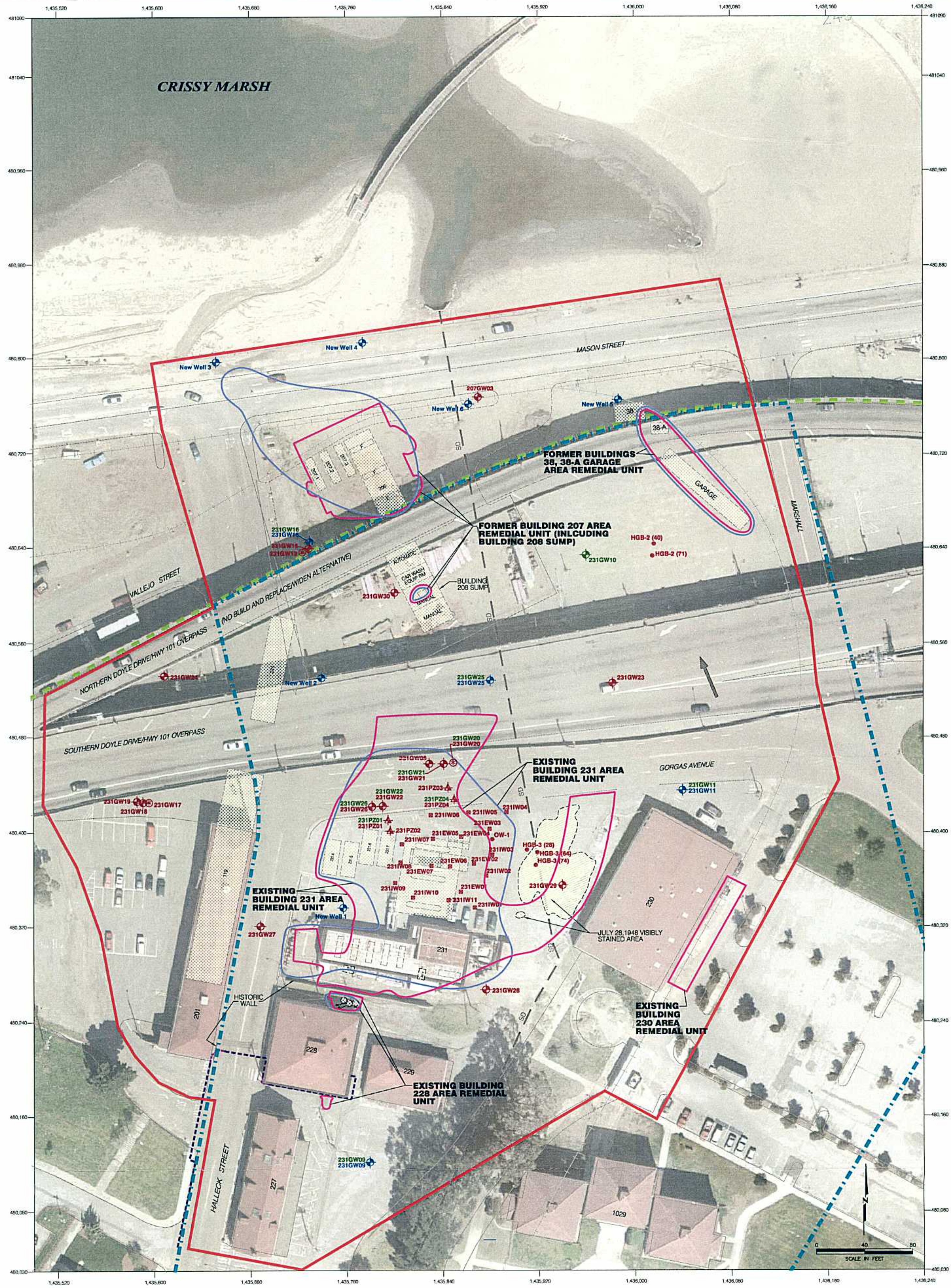
MACTEC

Corrective Action Plan

Building 207/231 Area
Presidio of San Francisco
San Francisco, California

**Proposed Excavation and Capping/Land Use Control Areas
Building 231 Area**

PLATE: **20b**



EXPLANATION

WELL COLOR CODING:

- 231GW10 — PROPOSED PRE-CONSTRUCTION MONITORING WELL
- 231GW09 — PROPOSED POST-CONSTRUCTION MONITORING WELL
- 231GW06 — PROPOSED FOR ABANDONMENT DURING REMEDIATION

- SVE AND GROUNDWATER INJECTION (IW) OR EXTRACTION (EW) WELL
- GROUNDWATER REMEDIAL UNITS
- SOIL REMEDIAL UNITS
- FORMER RAILROAD TRACKS
- MONITORING WELL - SHALLOW SAND
- MONITORING WELL - DEEP SAND
- PIEZOMETER - SHALLOW SAND

- 202 — FORMER STRUCTURE OR FEATURE
- BUILDING 207/231 AREA
- STAINED AREA
- SALTWATER ECOLOGICAL PROTECTION ZONE (NORTH OF GREEN LINE)
- FRESHWATER ECOLOGICAL PROTECTION ZONE (SOUTH AND EAST OF BLUE LINE)
- REMOVED FUEL DISTRIBUTION PIPELINE
- ABANDONED IN-PLACE FUEL DISTRIBUTION PIPELINE
- SD — TENNESSEE HOLLOW UNDERGROUND PIPELINE
- APPROXIMATE DIRECTION OF SHALLOW ZONE GROUNDWATER FLOW (MAY 24, 2004)

NOTE:
AERIAL PHOTOGRAPHY DATA MARCH 24, 2000 SOURCE: PRESIDIO TRUST GIS DEPARTMENT.

DRAWN: PCB	PROJECT NO: 4089041001 106	Corrective Action Plan	PLATE
ENGINEER: NAM	SCALE: AS SHOWN	Building 207/231 Area Presidio of San Francisco San Francisco, California	Proposed Groundwater Monitoring Network and Well Abandonment Locations
CHECKED:	APPROVED:		21
DATE: 07/06	DATE:		

MACTEC

APPENDIX A

SOIL AND GROUNDWATER DATA TABLES

(PROVIDED ON CD)

APPENDIX B

COST ESTIMATES AND ASSUMPTIONS FOR CORRECTIVE ACTION ALTERNATIVES

Summary of Corrective Action Alternative Costs
Corrective Action Plan Building 207/231 Area
Presidio of San Francisco, California

Remedial Unit	Recommended Corrective Action Alternative	Description of Corrective Action Alternative	CAPITAL COSTS (2006)	ANNUAL COSTS [(1)] (2006)	TOTAL COSTS (2006)	Cost Breakdown
Former Building 207 Area (Including Building 208 Sump)	--	Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring	$ 157,000	$ 57,000	$ 214,000	Table B-1
	x	Excavation with Backfill Option A--Open excavation with drainage to prevent overflow; Land Use Control and groundwater monitoring for 3 years	$ 287,000	$ 6,000	$ 293,000	Table B-2
		Excavation with Backfill Option B--Limited backfill with soil similar to native above high water-table elevation and revegetation; Land Use Control and groundwater monitoring for 3 years	$ 250,000	$ 6,000	$ 256,000	Table B-3
		Excavation with Backfill Option C--Complete backfill and repave to match existing conditions; Land Use Control and groundwater monitoring for 3 years	$ 332,000	$ 6,000	$ 338,000	Table B-4
Former Building 38, 38-A, and Garage Area	--	Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring	$ 104,000	$ 57,000	$ 161,000	Table B-5
	x	Excavation with Backfill Option A--Open excavation with drainage to prevent overflow; Land Use Control and groundwater monitoring for 3 years	$ 196,000	$ 6,000	$ 202,000	Table B-6
		Excavation with Backfill Option B--Limited backfill with soil similar to native above high water-table elevation and revegetation; Land Use Control and groundwater monitoring for 3 years	$ 202,000	$ 6,000	$ 208,000	Table B-7
		Excavation with Backfill Option C--Complete backfill and repave to match existing conditions; Land Use Control and groundwater monitoring for 3 years	$ 185,000	$ 6,000	$ 191,000	Table B-8
Existing Building 231 Area (Including Former Building 271 Area)	--	Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring	$ 611,000	$ 287,000	$ 898,000	Table B-9
	x	Excavation with Backfill Option A--Open excavation with drainage to prevent overflow and replacement of existing roadways only; Land Use Control and groundwater monitoring for 3 years	$ 1,559,000	$ 45,000	$ 1,604,000	Table B-10
		Excavation with Backfill Option B--Limited backfill with soil similar to native above high water-table elevation and revegetation, replacement of existing roadways; Land Use Control and groundwater monitoring for 3 years	$ 1,589,000	$ 45,000	$ 1,634,000	Table B-11
		Excavation with Backfill Option C--Complete backfill and repave to match existing conditions; Land Use Control and groundwater monitoring for 3 years	$ 1,802,000	$ 45,000	$ 1,847,000	Table B-12
Existing Building 228 Area	x	Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring	$ 118,000	$ 67,000	$ 185,000	Table B-13
Existing Building 230 Area	--	Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring	$ 143,000	$ 57,000	$ 200,000	Table B-14
	x	Excavation with Backfill Option C--Complete backfill and repave to match existing conditions; Land Use Control and groundwater monitoring for 3 years	$ 222,000	$ 6,000	$ 228,000	Table B-15
TOTAL COSTS FOR RECOMMENDED CORRECTIVE ACTION ALTERNATIVES BUILDING 207/231 CAP AREA			$ 2.33 to 2.68 million	$ 0.13 million	$ 2.46 to 2.81 million	

Cost estimates were prepared using the Presidio Unit Costs Master Reference Table; Version (1); July, 2006 [ATTACHMENT].
Site-specific assumptions are presented on Tables B-1 through B-15.
"Share of Cost" items for the 5 RUs were assigned as follows by size of RU (volume, area) or level of effort: Bldg 207 = 10%; Bldg 38 = 10%; Bldg 231 = 60%; Bldg 228 = 10%; Bldg 230 = 10%. These items include: (1) Mobilization, Dewatering, Drainage; (2) Revegetation; (3) Implement Land Use Controls; (4) Groundwater Monitoring & Well Installation/Abandonment; (5) Planning & Remedial Design ; (6) Work Plan; (7) Construction Report.

[(1)] Net Present Value (NPV) of estimated annual costs.

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Approved ____________________

Summary of Corrective Action Alternative Costs
Corrective Action Plan Building 207/231 Area
Presidio of San Francisco, California

Remedial Unit	Recommended Corrective Action Alternative	Description of Corrective Action Alternative	CAPITAL COSTS (2006)	ANNUAL COSTS [1] (2006)	TOTAL COSTS (2006)	Cost Breakdown
Former Building 207 Area (Including Building 208 Sump)	--	Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring	$ 157,000	$ 57,000	$ 214,000	Table B-1
	X	Excavation with Backfill Option A--Open excavation with drainage to prevent overflow; Land Use Control and groundwater monitoring for 3 years	$ 287,000	$ 6,000	$ 293,000	Table B-2
		Excavation with Backfill Option B--Limited backfill with soil similar to native above high water-table elevation and revegetation; Land Use Control and groundwater monitoring for 3 years	$ 250,000	$ 6,000	$ 256,000	Table B-3

Table B-1. Summary of Estimated Costs for
Capping and Land Use Controls
Former Building 207 Area (Including Former Building 208 Sump)
Corrective Action Plan Building 207/231 Area, Presidio of San Francisco, California

Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	**Task Description**	**Unit**	**Quantity**	**Unit Cost**	**Subtotal**	**Total** *(thousands)*
	CAPITAL COSTS					
	Capping/Capping Improvements					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	30%	$ 30,000	$ 9,000	
	Vegetative cap/capping improvements of unpaved areas					
[C]	Excavate soil, stockpile, load in end-dump truck or backfill clean soils into excavation	cy	780	$ 10	$ 7,800	
[C]	Install 40-mil geotextile fabric to separate underlying soil / revegation horizon	sf	7,000	$ 2	$ 14,000	
[C] share of cost	VMP In Dune Sand	ls	30%	$ 52,200	$ 15,660	
	Implement Land Use Control					
[C] share of cost	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A:B;G] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[A] share of cost; Table 7	Install and sample 6 new wells	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 64,000
	Design and Construction Management					
	Engineering					
[E] share of cost	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	1.5	$ 5,950	$ 8,925	
[E]	Engineering technician	wk	0.5	$ 3,570	$ 1,785	
[E]	Field administrative support	wk	1.5	$ 2,380	$ 3,570	
[E]	Field Vehicles and equipment	wk	1.5	$ 1,547	$ 2,321	
[E]	Archeological Monitoring	wk	0.3	$ 4,760	$ 1,428	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
						$ 55,000
[E]	Engineering Project Management	ls	10%			$ 6,000
	Subtotal Estimated Costs					$ 125,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 6,000
	Subtotal Estimated Costs					$ 131,000
[E]	*Contingencies*	ls	20%			$ 26,000
	Total Preliminary Estimated Capital Costs					**$ 157,000**

Table B-1. Summary of Estimated Costs for
Capping and Land Use Controls
Former Building 207 Area (Including Former Building 208 Sump)
Corrective Action Plan Building 207/231 Area, Presidio of San Francisco, California

Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total *(thousands)*
	ANNUAL COSTS					
[G]	Annualized cost of 5-year Inspections & Repars - Small Remedial Unit or Site (Years 1-30)	ls	1	$ 500	$ 500	
	LUC Management -- Share of Cost (Years 1-30)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 2,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Annual Groundwater Monitoring (Years 2-10)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 10 yrs @ 2.8%	*Years 1-10 Present Worth of Annual Costs*					$ 27,000
[G] 20 yrs @ 3%	*Years 11-30 Present Worth of Annual Costs*					$ 30,000
	Total Preliminary Estimated Present Worth of 30-Year Annual Costs					**$ 57,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 214,000**

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Table B-2. Summary of Estimated Costs for Excavation with Backfill Option A (Open Excavation with Drainage) Former Building 207 Area (Including Former Building 208 Sump) Presidio of San Francisco, California

Open Excavation - Excavation open with drainage to prevent overflow, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	800	$ 7	$ 5,600	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	1,130	$ 10	$ 11,300	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 115,000	$ 11,500	
estimate	Install permanent open excavation drainage piping	ft	80	$ 100	$ 8,000	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	20	$ 35	$ 700	
[B] 3-Day TAT	TPHg/BTEX/MTBE (EPA Method 8015/8021)	ea	20	$ 175	$ 3,500	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	20	$ 113	$ 2,260	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	20	$ 225	$ 4,500	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	20	$ 70	$ 1,400	
[B]	Data Validation (Independent 3rd Party)	ea	20	$ 34	$ 680	
[B]	Input analytical results into Presidio database	ea	20	$ 18	$ 360	
	Site Restoration					
[C] share of cost; 1acre	Stabilize excavation/revegetate as dune habitat	ls	30%	$ 52,200	$ 15,660	
	Transport and Dispose Soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	3	$ 35	$ 105	
[B] 3-Day TAT	Metals (EPA Method 6010)	ea	3	$ 180	$ 540	
[B] 3-Day TAT	Waste Extraction Test (STLC) (extraction only)	ea	3	$ 113	$ 339	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	450	$ 24	$ 10,800	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	570	$ 35	$ 19,950	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	110	$ 70	$ 7,700	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 125,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost; multiple sites	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	3	$ 5,950	$ 17,850	
[E]	Field engineer to coordinate disposal issues	wk	0.5	$ 5,950	$ 2,975	
[E]	Engineering technician	wk	1	$ 5,950	$ 5,950	
[E]	Geotechnical and compaction testing	wk	0.5	$ 3,868	$ 1,934	
[E]	Air monitoring	wk	1	$ 1,190	$ 1,190	
[E]	Field administrative support	wk	3	$ 5,950	$ 17,850	
[E]	Field Vehicles and equipment	wk	3	$ 1,547	$ 4,641	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeology monitoring	wk	1.0	$ 4,760	$ 4,760	
						$ 94,000
[E]	Engineering Project Management	ls	10%			$ 9,000
	Subtotal Estimated Costs					$ 228,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 11,000
	Subtotal Estimated Costs					$ 239,000
[E]	*Contingencies*	ls	20%			$ 48,000
	Total Preliminary Estimated Capital Costs					**$ 287,000**

Table B-2. Summary of Estimated Costs for
Excavation with Backfill Option A (Open Excavation with Drainage)
Former Building 207 Area (Including Former Building 208 Sump)
Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	**Task Description**	**Unit**	**Quantity**	**Unit Cost**	**Subtotal**	**Total** *(thousands)*
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 1,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, C] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, C] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 6,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 6,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 293,000**

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Table B-3. Summary of Estimated Costs for
Excavation with Backfill Option B (Limited Backfill)
Former Building 207 Area (Including Former Building 208 Sump)
CAP Building 207/231
Presidio of San Francisco, California

Limited Backfill - Excavation open, backfill with soil similar to native above high water-table elevation and revegetation, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	800	$ 7	$ 5,600	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	1,130	$ 10	$ 11,300	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 75,000	$ 7,500	
estimate	Install permanent open excavation drainage piping	ft	80	$ 100	$ 8,000	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 30,000	$ 3,000	
[C] share of cost; multiple sites	Profile Backfill Material	ls	10%	$ 8,400	$ 840	
[C]	Backfill excavation - Onsite borrow source: procure, transport, place and compact	cy	530	$ 10	$ 5,300	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	20	$ 35	$ 700	
[B] 3-Day TAT	TPHg/BTEX/MTBE (EPA Method 8015/8021)	ea	20	$ 175	$ 3,500	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	20	$ 113	$ 2,260	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	20	$ 225	$ 4,500	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	20	$ 70	$ 1,400	
[B]	Data Validation (Independent 3rd Party)	ea	20	$ 34	$ 680	
[B]	Input analytical results into Presidio database	ea	20	$ 18	$ 360	
	Site Restoration					
[C] share of cost; 1acre	Stabilize excavation/revegetate as dune habitat	ls	30%	$ 52,200	$ 15,660	
	Transport and Dispose Soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	5	$ 35	$ 175	
[C]	Disposal characterization	ea	5	$ 320	$ 1,600	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	30	$ 24	$ 720	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	40	$ 35	$ 1,400	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	10	$ 70	$ 700	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 95,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost; multiple sites	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	3	$ 5,950	$ 17,850	
[E]	Field engineer to coordinate disposal issues	wk	0.5	$ 5,950	$ 2,975	
[E]	Engineering technician	wk	1	$ 5,950	$ 5,950	
[E]	Geotechnical and compaction testing	wk	0.5	$ 3,868	$ 1,934	
[E]	Air monitoring	wk	1	$ 1,190	$ 1,190	
[E]	Field administrative support	wk	3	$ 5,950	$ 17,850	
[E]	Vehicles and equipment	wk	3	$ 1,547	$ 4,641	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeology monitoring	wk	1.0	$ 4,760	$ 4,760	
						$ 94,000
[E]	Engineering Project Management	ls	10%			$ 9,000
	Subtotal Estimated Costs					$ 198,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 10,000
	Subtotal Estimated Costs					$ 208,000
[E]	*Contingencies*	ls	20%			$ 42,000
	Total Preliminary Estimated Capital Costs					**$ 250,000**

Table B-3. Summary of Estimated Costs for
Excavation with Backfill Option B (Limited Backfill)
Former Building 207 Area (Including Former Building 208 Sump)
CAP Building 207/231
Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 1,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 6,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 6,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 256,000**

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Table B-4. Summary of Estimated Costs for
Excavation With Backfill Option C (Complete Backfill)
Former Building 207 Area (Including Former Building 208 Sump)
CAP Building 207/231
Presidio of San Francisco, California

Complete Backfill - Backfill and repave to match existing conditions, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	800	$ 7	$ 5,600	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	1,130	$ 10	$ 11,300	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 75,000	$ 7,500	
[C] share of cost; multiple sites	Profile Backfill Material	ls	10%	$ 8,400	$ 840	
] 80% of in-place cy for swell, paving	Backfill excavation - Imported / offsite borrow source: procure, transport, place and compact	cy	900	$ 24	$ 21,600	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	20	$ 35	$ 700	
[B] 3-Day TAT	TPHg/BTEX/MTBE (EPA Method 8015/8021)	ea	20	$ 175	$ 3,500	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	20	$ 113	$ 2,260	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	20	$ 225	$ 4,500	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	20	$ 70	$ 1,400	
[B]	Data Validation (Independent 3rd Party)	ea	20	$ 34	$ 680	
[B]	Input analytical results into Presidio database	ea	20	$ 18	$ 360	
	Site Restoration					
[C]	Repave excavated area (Asphalt)	sf	8500	$ 4	$ 34,000	
[C]	Replace curbs/gutters	lf	200	$ 33	$ 6,600	
	Transport and Dispose Soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	5	$ 35	$ 175	
[C]	Disposal characterization	ea	5	$ 320	$ 1,600	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	450	$ 24	$ 10,800	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	570	$ 35	$ 19,950	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	110	$ 70	$ 7,700	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 161,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost; multiple sites	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	3	$ 5,950	$ 17,850	
[E]	Field engineer to coordinate disposal issues	wk	0.5	$ 5,950	$ 2,975	
[E]	Engineering technician	wk	1	$ 5,950	$ 5,950	
[E]	Geotechnical and compaction testing	wk	0.5	$ 3,868	$ 1,934	
[E]	Air monitoring	wk	1	$ 1,190	$ 1,190	
[E]	Field administrative support	wk	3	$ 5,950	$ 17,850	
[E]	Vehicles and equipment	wk	3	$ 1,547	$ 4,641	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeology monitoring	wk	1.0	$ 4,760	$ 4,760	
						$ 94,000
[E]	Engineering Project Management	ls	10%			$ 9,000
	Subtotal Estimated Costs					$ 264,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 13,000
	Subtotal Estimated Costs					$ 277,000
[E]	*Contingencies*	ls	20%			$ 55,000
	Total Preliminary Estimated Capital Costs					**$ 332,000**

Table B-4. Summary of Estimated Costs for
Excavation With Backfill Option C (Complete Backfill)
Former Building 207 Area (Including Former Building 208 Sump)
CAP Building 207/231
~~Presidio of San Francisco, California~~

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 1,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 6,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 6,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 338,000**

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Table B-5. Summary of Estimated Costs for
Capping and Land Use Controls
Former Building 38, 38-A, Garage Area
Corrective Action Plan Building 207/231 Area Corrective Action Plan, Presidio of San Francisco, California

Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Inspect Existing Cover for Improvements and Repair					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
	Asphalt cap/capping improvements of paved areas					
[C]	Sawcut, demolish, recycle asphalt	sf	250	$ 4	$ 1,000	
[C]	Seal / repave asphalt	sf	250	$ 4	$ 1,000	
	Implement Land Use Control					
[C] share of cost	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 22,000
	Design and Construction Management					
	Engineering					
[E] share of cost	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	1.5	$ 5,950	$ 8,925	
[E]	Engineering technician	wk	0.5	$ 3,570	$ 1,785	
[E]	Field adiminstrative support	wk	1.5	$ 2,380	$ 3,570	
[E]	Vehicles and equipment	wk	1.5	$ 1,547	$ 2,321	
[E]	Archeological Monitoring	wk	0.3	$ 4,760	$ 1,428	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
						$ 55,000
[E]	Engineering Project Management	ls	10%			$ 6,000
	Subtotal Estimated Costs					$ 83,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 4,000
	Subtotal Estimated Costs					$ 87,000
[E]	*Contingencies*	ls	20%			$ 17,000
	Total Preliminary Estimated Capital Costs					**$ 104,000**
	ANNUAL COSTS					
[G]	Annual Cap Inspection, Maintenance, Repair (Years 1-30)	ls	1	$ 500	$ 500	
	LUC Management -- Share of Cost (Years 1-30)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 2,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Annual Groundwater Monitoring (Years 2-10)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 10 yrs @ 2.8%	*Years 1-10 Present Worth of Annual Costs*					$ 27,000
[G] 20 yrs @ 3%	*Years 11-30 Present Worth of Annual Costs*					$ 30,000
	Total Preliminary Estimated Present Worth of 30-Year Annual Costs					**$ 57,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 161,000**

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Table B-6. Summary of Estimated Costs for Excavation with Backfill Option A (Open Excavation with Drainage) Former Building 38, 38-A, Garage Area, Presidio of San Francisco, California

Open Excavation - Excavation open with drainage to prevent overflow,Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total *(thousands)*
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	400	$ 7	$ 2,800	
[C]	Sawcut, demolish, recycle asphalt	sf	250	$ 4	$ 1,000	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	670	$ 10	$ 6,700	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 75,000	$ 7,500	
estimate	Install permanent open excavation drainage piping	ft	120	$ 100	$ 12,000	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 30,000	$ 3,000	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	12	$ 35	$ 420	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	12	$ 113	$ 1,356	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	12	$ 225	$ 2,700	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	12	$ 70	$ 840	
[B]	Data Validation (Independent 3rd Party)	ea	12	$ 34	$ 408	
[B]	Input analytical results into Presidio database	ea	12	$ 18	$ 216	
	Site Restoration					
[C] share of cost; 1acre	Stabilize excavation/revegetate as dune habitat	ls	10%	$ 52,200	$ 5,220	
	Transport and dispose of soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	2	$ 35	$ 70	
[B] 3-Day TAT	Metals (EPA Method 6010)	ea	3	$ 180	$ 540	
[B] 3-Day TAT	Waste Extraction Test (STLC) (extraction only)	ea	3	$ 113	$ 339	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	270	$ 24	$ 6,480	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	340	$ 35	$ 11,900	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	70	$ 70	$ 4,900	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 89,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost; multiple sites	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	1	$ 5,950	$ 5,950	
[E]	Field engineer to coordinate disposal issues	wk	0.5	$ 5,950	$ 2,975	
[E]	Engineering technician	wk	0.5	$ 5,950	$ 2,975	
[E]	Geotechnical and compaction testing	wk	0.5	$ 3,868	$ 1,934	
[E]	Air monitoring	wk	0.5	$ 1,190	$ 595	
[E]	Field administrative support	wk	1	$ 5,950	$ 5,950	
[E]	Vehicles and equipment	wk	1	$ 1,547	$ 1,547	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeology monitoring	wk	0.3	$ 4,760	$ 1,428	
						$ 60,000
[E]	Engineering Project Management	ls	10%			$ 6,000
	Subtotal Estimated Costs					$ 155,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 8,000
	Subtotal Estimated Costs					$ 163,000
[E]	*Contingencies*	ls	20%			$ 33,000
	Total Preliminary Estimated Capital Costs					**$ 196,000**

Table B-6. Summary of Estimated Costs for
Excavation with Backfill Option A (Open Excavation with Drainage)
Former Building 38, 38-A, Garage Area, Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 1,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 6,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 6,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 202,000**

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Table B-7. Summary of Estimated Costs for
Excavation with Backfill Option B (Limited Backfill)
Former Building 38, 38-A, Garage Area, Presidio of San Francisco, California

Limited Backfill - Excavation open, backfill with soil similar to native above high water-table elevation and revegetation, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	400	$ 7	$ 2,800	
[C]	Sawcut, demolish, recycle asphalt	sf	250	$ 4	$ 1,000	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	670	$ 10	$ 6,700	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 75,000	$ 7,500	
estimate	Install permanent open excavation drainage piping	ft	120	$ 100	$ 12,000	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 30,000	$ 3,000	
[C] share of cost; multiple sites	Profile backfill materials	ls	10%	$ 8,400	$ 840	
[C]	Backfill excavation - Onsite borrow source: procure, transport, place and compact	cy	310	$ 10	$ 3,100	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	12	$ 35	$ 420	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	12	$ 113	$ 1,356	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	12	$ 225	$ 2,700	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	12	$ 180	$ 2,160	
[B]	Data Validation (Independent 3rd Party)	ea	12	$ 34	$ 408	
[B]	Input analytical results into Presidio database	ea	12	$ 18	$ 216	
	Site Restoration					
[C] share of cost; 1acre	Stabilize excavation/revegetate as dune habitat	ls	10%	$ 52,200	$ 5,220	
	Transport and dispose of soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	2	$ 35	$ 70	
[B] 3-Day TAT	Metals (EPA Method 6010)	ea	3	$ 180	$ 540	
[B] 3-Day TAT	Waste Extraction Test (STLC) (extraction only)	ea	3	$ 113	$ 339	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	270	$ 24	$ 6,480	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	340	$ 35	$ 11,900	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	70	$ 70	$ 4,900	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 94,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost; multiple sites	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	1	$ 5,950	$ 5,950	
[E]	Field engineer to coordinate disposal issues	wk	0.5	$ 5,950	$ 2,975	
[E]	Engineering technician	wk	0.5	$ 5,950	$ 2,975	
[E]	Geotechnical and compaction testing	wk	0.5	$ 3,868	$ 1,934	
[E]	Air monitoring	wk	0.5	$ 1,190	$ 595	
[E]	Field administrative support	wk	1	$ 5,950	$ 5,950	
[E]	Vehicles and equipment	wk	1	$ 1,547	$ 1,547	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeology monitoring	wk	0.3	$ 4,760	$ 1,428	
						$ 60,000
[E]	Engineering Project Management	ls	10%			$ 6,000
	Subtotal Estimated Costs					$ 160,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 8,000
	Subtotal Estimated Costs					$ 168,000
[E]	*Contingencies*	ls	20%			$ 34,000
	Total Preliminary Estimated Capital Costs					**$ 202,000**

Table B-7. Summary of Estimated Costs for
Excavation with Backfill Option B (Limited Backfill)
Former Building 38, 38-A, Garage Area, Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	**Task Description**	**Unit**	**Quantity**	**Unit Cost**	**Subtotal**	**Total** *(thousands)*
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 1,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 6,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 6,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 208,000**

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Table B-8. Summary of Estimated Costs for Excavation with Backfill Option C (Complete Backfill) Former Building 38, 38-A, Garage Area, Presidio of San Francisco, California

Complete Backfill - Backfill and repave to match existing conditions, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	400	$ 7	$ 2,800	
[C]	Sawcut, demolish, recycle asphalt	sf	250	$ 4	$ 1,000	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	670	$ 10	$ 6,700	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 75,000	$ 7,500	
[C] share of cost; multiple sites	Profile Backfill Material	ls	10%	$ 8,400	$ 840	
] 80% of in-place cy for swell, paving	Backfill excavation - Imported / offsite borrow source: procure, transport, place and compact	cy	540	$ 24	$ 12,960	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	12	$ 35	$ 420	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	12	$ 113	$ 1,356	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	12	$ 225	$ 2,700	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	12	$ 180	$ 2,160	
[B]	Data Validation (Independent 3rd Party)	ea	12	$ 34	$ 408	
[B]	Input analytical results into Presidio database	ea	12	$ 18	$ 216	
	Site Restoration					
[C]	Repave excavated area (Asphalt)	sf	1800	$ 4	$ 7,200	
	Transport and dispose of soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	2	$ 35	$ 70	
[B] 3-Day TAT	Metals (EPA Method 6010)	ea	3	$ 180	$ 540	
[B] 3-Day TAT	Waste Extraction Test (STLC) (extraction only)	ea	3	$ 113	$ 339	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	160	$ 24	$ 3,840	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	200	$ 35	$ 7,000	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	40	$ 70	$ 2,800	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 81,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost; multiple sites	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	1	$ 5,950	$ 5,950	
[E]	Field engineer to coordinate disposal issues	wk	0.5	$ 5,950	$ 2,975	
[E]	Engineering technician	wk	0.5	$ 5,950	$ 2,975	
[E]	Geotechnical and compaction testing	wk	0.5	$ 3,868	$ 1,934	
[E]	Air monitoring	wk	0.5	$ 1,190	$ 595	
[E]	Field administrative support	wk	1	$ 5,950	$ 5,950	
[E]	Vehicles and equipment	wk	1	$ 1,547	$ 1,547	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeology monitoring	wk	0.3	$ 4,760	$ 1,428	
						$ 60,000
[E]	Engineering Project Management	ls	10%			$ 6,000
	Subtotal Estimated Costs					$ 147,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 7,000
	Subtotal Estimated Costs					$ 154,000
[E]	*Contingencies*	ls	20%			$ 31,000
	Total Preliminary Estimated Capital Costs					**$ 185,000**

Table B-8. Summary of Estimated Costs for Excavation with Backfill Option C (Complete Backfill) Former Building 38, 38-A, Garage Area, Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 1,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 6,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 6,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 191,000**

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Table B-9. Summary of Estimated Costs for
Capping and Land Use Controls
Building 231 Area (Including Former Building 271 Area)
Corrective Action Plan Building 207/231 Area,
Presidio of San Francisco, California

Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Inspect Existing Cover for Improvements and Repair					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	60%	$ 30,000	$ 18,000	
	Asphalt cap/capping improvements of paved areas					
[C]	Sawcut, demolish, recycle asphalt	sf	8,500	$ 4	$ 34,000	
[C]	Seal / repave asphalt	sf	8,500	$ 4	$ 34,000	
[C]	Replace curbs/gutters	lf	100	$ 33	$ 3,300	
[A,B,C] share of cost; multiple sites	Indoor air monitoring, building inspection	ls	33%	$ 30,000	$ 9,900	
	Implement Land Use Control					
[C] share of cost	Prepare Site-Specific Addendum to LUCMRR	ls	60%	$ 10,000	$ 6,000	
[C] share of cost	Share of cost to prepare LUCMRR	ls	60%	$ 5,000	$ 3,000	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[B;G] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox	ls	60%	$ 24,000	$ 14,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells	ls	60%	$ 32,000	$ 19,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	60%	$ 102,000	$ 61,200	
	Subtotal Direct Costs					$ 203,000
	Design and Construction Management					
[E] share of cost	Planning and Remedial Design	ls	60%	$ 120,000	$ 72,000	
[E] share of cost	Implementation Work Plan	ls	60%	$ 100,000	$ 60,000	
	Construction observation					
[E]	Resident engineer	wk	3	$ 5,950	$ 17,850	
[E]	Engineering technician	wk	1.5	$ 3,570	$ 5,355	
[E]	Field administrative support	wk	2	$ 2,380	$ 4,760	
[E]	Vehicles and equipment	wk	3	$ 1,547	$ 4,641	
[E]	Archeological Monitoring	wk	0.3	$ 4,760	$ 1,428	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	60%	$ 150,000	$ 90,000	
						$ 256,000
[E]	Engineering Project Management	ls	10%			$ 26,000
	Subtotal Estimated Costs					$ 485,000
	Legal and Administrative Costs	ls	5%			$ 24,000
	Subtotal Estimated Costs					$ 509,000
	Contingencies	ls	20%			$ 102,000
	Total Preliminary Estimated Capital Costs					**$ 611,000**
	ANNUAL COSTS					
[G]	Annual Cap Inspection, Maintenance, Repair (Years 1-30)	ls	1	$ 500	$ 500	
	LUC Management -- Share of Cost (Years 1-30)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	60%	$ 10,000	$ 6,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	60%	$ 4,000	$ 2,400	
						$ 9,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs	ls	60%	$ 22,000	$ 13,200	$ 13,000
	Conduct Post-Construction Annual Groundwater Monitoring (Years 2-10)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs	ls	60%	$ 14,000	$ 8,400	$ 8,000
[G] 10 yrs @ 2.8%	*Years 1-10 Present Worth of Annual Costs*					$ 153,000
[G] 20 yrs @ 3%	*Years 11-30 Present Worth of Annual Costs*					$ 134,000
	Total Preliminary Estimated Present Worth of 30-Year Annual Costs					**$ 287,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 898,000**

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Table B-10. Summary of Estimated Costs for
Excavation with Backfill Option A (Open Excavation with Drainage)
Building 231 Area (Including Former Building 271 Area), Presidio of San Francisco, California

Open Excavation - Excavation open with drainage to prevent overflow and backfilling roadways only, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	60%	$ 30,000	$ 18,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	1260	$ 7	$ 8,820	
estimate	Demolish Building 231	ls	1	$ 80,000	$ 80,000	
[C]	Sawcut, demolish, recycle asphalt	sf	14,500	$ 4	$ 58,000	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	7,200	$ 10	$ 72,000	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	60%	$ 75,000	$ 45,000	
estimate	Install permanent open excavation drainage piping	ft	120	$ 100	$ 12,000	
[C] share of cost; multiple sites	Construct open excavation drainage system	ls	60%	$ 30,000	$ 18,000	
[C] Includes Former Bldg 271 Area	Install geomembrane (northern excavation boundary/Doyle Dr)	sf	2,500	$ 2	$ 5,000	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	85	$ 35	$ 2,975	
[B] 3-Day TAT	TPHg/BTEX/MTBE (EPA Method 8015/8021)	ea	85	$ 175	$ 14,875	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	85	$ 113	$ 9,605	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	85	$ 225	$ 19,125	
[B] 3-Day TAT	VOCs (EPA Method 8260)	ea	85	$ 113	$ 9,605	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	85	$ 70	$ 5,950	
[B] 3-Day TAT	PCBs (EPA Method 8082)	ea	85	$ 105	$ 8,925	
[B]	Data Validation (Independent 3rd Party)	ea	85	$ 34	$ 2,890	
[B]	Input analytical results into Presidio database	ea	85	$ 18	$ 1,530	
	Site Restoration					
[C] share of cost; 1acre	Stabilize excavation/revegetate as dune habitat	ls	60%	$ 52,200	$ 31,320	
	Replace Gorgas Ave roadway section					
[C]	Backfill excavation - imported / offsite borrow source: procure, transport, place and compact	cy	1,350	$ 24	$ 32,400	
[C]	Repave roadway	sy	600	$ 150	$ 90,000	
[C]	Replace curbs/gutters	lf	200	$ 33	$ 6,600	
	Transport and dispose of soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	17	$ 35	$ 595	
[B] 3-Day TAT	Metals (EPA Method 6010)	ea	17	$ 180	$ 3,060	
[B] 3-Day TAT	Waste Extraction Test (STLC) (extraction only)	ea	17	$ 113	$ 1,921	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	2,880	$ 24	$ 69,120	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	3,600	$ 35	$ 126,000	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	720	$ 70	$ 50,400	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	60%	$ 10,000	$ 6,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	60%	$ 5,000	$ 3,000	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	60%	$ 24,000	$ 14,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	60%	$ 32,000	$ 19,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	60%	$ 102,000	$ 61,200	
	Subtotal Direct Costs					$ 908,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	60%	$ 120,000	$ 72,000	
[C] share of cost; multiple sites	Implementation Work Plan	ls	60%	$ 100,000	$ 60,000	
	Construction observation					
[E]	Resident engineer	wk	1	$ 5,950	$ 5,950	
[E]	Field engineer to coordinate disposal issues	wk	3	$ 5,950	$ 17,850	
[E]	Engineering technician	wk	3	$ 5,950	$ 17,850	
[E]	Geotechnical and compaction testing	wk	1.5	$ 3,868	$ 5,802	
[E]	Air monitoring	wk	2	$ 1,190	$ 2,380	
[E]	Field administrative support	wk	3	$ 5,950	$ 17,850	
[E]	Vehicles and equipment	wk	3	$ 1,547	$ 4,641	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	60%	$ 150,000	$ 90,000	
[E]	Archeology monitoring	wk	1.0	$ 4,760	$ 4,760	
						$ 299,000

Table B-10. Summary of Estimated Costs for
Excavation with Backfill Option A (Open Excavation with Drainage)
Building 231 Area (Including Former Building 271 Area), Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
[E]	Engineering Project Management	ls	10%			$ 30,000
	Subtotal Estimated Costs					$ 1,237,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 62,000
	Subtotal Estimated Costs					$ 1,299,000
[E]	*Contingencies*	ls	20%			$ 260,000
	Total Preliminary Estimated Capital Costs					**$ 1,559,000**
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	60%	$ 10,000	$ 6,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	60%	$ 4,000	$ 2,400	
						$ 8,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	60%	$ 22,000	$ 13,200	$ 13,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	60%	$ 14,000	$ 8,400	$ 8,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 45,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 45,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 1,604,000**

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Table B-11. Summary of Estimated Costs for
Excavation with Backfill Option B (Limited Backfill)
Building 231 Area (Including Former Building 271 Area), Presidio of San Francisco, California

Limited Backfill - Excavation open, backfill with soil similar to native above high water-table elevation and revegetation, replacement of existing roadways, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	60%	$ 30,000	$ 18,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	1260	$ 7	$ 8,820	
estimate	Demolish Building 231	ls	1	$ 80,000	$ 80,000	
[C]	Sawcut, demolish, recycle asphalt	sf	14,500	$ 4	$ 58,000	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	7,200	$ 10	$ 72,000	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	60%	$ 75,000	$ 45,000	
estimate	Install permanent open excavation drainage piping	ft	120	$ 100	$ 12,000	
[C] share of cost; multiple sites	Construct open excavation drainage system	ls	60%	$ 30,000	$ 18,000	
[C] Includes Former Bldg 271 Area	Install geomembrane (northern excavation boundary/Doyle Dr)	sf	2,500	$ 1.2	$ 3,000	
[C] share of cost; multiple sites	Profile Backfill Material	ls	60%	$ 8,400	$ 5,040	
[C]	Backfill excavation - Onsite borrow source: procure, transport, place and compact	cy	2,100	$ 10	$ 21,000	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	85	$ 35	$ 2,975	
[B] 3-Day TAT	TPHg/BTEX/MTBE (EPA Method 8015/8021)	ea	85	$ 175	$ 14,875	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	85	$ 113	$ 9,605	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	85	$ 225	$ 19,125	
[B] 3-Day TAT	VOCs (EPA Method 8260)	ea	85	$ 113	$ 9,605	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	85	$ 70	$ 5,950	
[B] 3-Day TAT	PCBs (EPA Method 8082)	ea	85	$ 105	$ 8,925	
[B]	Data Validation (Independent 3rd Party)	ea	85	$ 34	$ 2,890	
[B]	Input analytical results into Presidio database	ea	85	$ 18	$ 1,530	
	Site Restoration					
[C] share of cost; 1acre	Stabilize excavation / revegetate as dune habitat	ls	60%	$ 52,200	$ 31,320	
	Replace Gorgas Ave roadway section					
[C]	Backfill excavation - imported / offsite borrow source: procure, transport, place and compact	cy	1,350	$ 24	$ 32,400	
[C]	Repave roadway	sy	600	$ 150	$ 90,000	
[C]	Replace curbs/gutters	lf	200	$ 33	$ 6,600	
	Transport and dispose of soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	17	$ 35	$ 595	
[B] 3-Day TAT	Metals (EPA Method 6010)	ea	17	$ 180	$ 3,060	
[B] 3-Day TAT	Waste Extraction Test (STLC) (extraction only)	ea	17	$ 113	$ 1,921	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	2,880	$ 24	$ 69,120	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	3,600	$ 35	$ 126,000	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	720	$ 70	$ 50,400	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	60%	$ 10,000	$ 6,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	60%	$ 5,000	$ 3,000	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	60%	$ 24,000	$ 14,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	60%	$ 32,000	$ 19,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	60%	$ 102,000	$ 61,200	
	Subtotal Direct Costs					$ 932,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	60%	$ 120,000	$ 72,000	
[C] share of cost; multiple sites	Implementation Work Plan	ls	60%	$ 100,000	$ 60,000	
	Construction observation					
[E]	Resident engineer	wk	1	$ 5,950	$ 5,950	
[E]	Field engineer to coordinate disposal issues	wk	3	$ 5,950	$ 17,850	
[E]	Engineering technician	wk	3	$ 5,950	$ 17,850	
[E]	Geotechnical and compaction testing	wk	1.5	$ 3,868	$ 5,802	
[E]	Air monitoring	wk	2	$ 1,190	$ 2,380	
[E]	Field administrative support	wk	3	$ 5,950	$ 17,850	
[E]	Vehicles and equipment	wk	3	$ 1,547	$ 4,641	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	60%	$ 150,000	$ 90,000	
[E]	Archeology monitoring	wk	1.0	$ 4,760	$ 4,760	
						$ 299,000

Table B-11. Summary of Estimated Costs for
Excavation with Backfill Option B (Limited Backfill)
Building 231 Area (Including Former Building 271 Area), Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	**Task Description**	**Unit**	**Quantity**	**Unit Cost**	**Subtotal**	**Total** *(thousands)*
[E]	Engineering Project Management	ls	10%			$ 30,000
	Subtotal Estimated Costs					$ 1,261,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 63,000
	Subtotal Estimated Costs					$ 1,324,000
[E]	*Contingencies*	ls	20%			$ 265,000
	Total Preliminary Estimated Capital Costs					**$ 1,589,000**
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	60%	$ 10,000	$ 6,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	60%	$ 4,000	$ 2,400	
						$ 8,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	60%	$ 22,000	$ 13,200	$ 13,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	60%	$ 14,000	$ 8,400	$ 8,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 45,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 45,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 1,634,000**

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Table B-12. Summary of Estimated Costs for Excavation with Backfill Option C (Complete Backfill) Building 231 Area (Including Former Building 271 Area), Presidio of San Francisco, California

Complete Backfill - Backfill and repave to match existing conditions, replacement of existing roadways, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	60%	$ 30,000	$ 18,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	1260	$ 7	$ 8,820	
estimate	Demolish Building 231	ls	1	$ 80,000	$ 80,000	
[C]	Sawcut, demolish, recycle asphalt	sf	14,500	$ 4	$ 58,000	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	7,200	$ 10	$ 72,000	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	60%	$ 75,000	$ 45,000	
Includes Former Bldg 271 Area	Install geomembrane (northern excavation boundary/Doyle Dr)	sf	2,500	$ 1.2	$ 3,000	
[C] share of cost; multiple sites	Profile Backfill Material	ls	60%	$ 8,400	$ 5,040	
[C]80% of in-place cy for swell, paving	Backfill excavation - imported / offsite borrow source: procure, transport, place and compact	cy	5,760	$ 24	$ 138,240	
	Excavation Confirmation Sampling					
[C] fulltime; 50-ft; 10% QA/QC	Collect Soil Samples	ea	85	$ 35	$ 2,975	
[B] 3-Day TAT	TPHg/BTEX/MTBE (EPA Method 8015/8021)	ea	85	$ 175	$ 14,875	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	85	$ 113	$ 9,605	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	85	$ 225	$ 19,125	
[B] 3-Day TAT	VOCs (EPA Method 8260)	ea	85	$ 113	$ 9,605	
[B] 3-Day TAT	Pb, Zn (EPA Method 6010)	ea	85	$ 70	$ 5,950	
[B] 3-Day TAT	PCBs (EPA Method 8082)	ea	85	$ 105	$ 8,925	
[B]	Data Validation (Independent 3rd Party)	ea	85	$ 34	$ 2,890	
[B]	Input analytical results into Presidio database	ea	85	$ 18	$ 1,530	
	Site Restoration					
[C]	Repave excavated area	sf	28,300	$ 4	$ 113,200	
[C]	Backfill excavation - imported / offsite borrow source: procure, transport, place and compact	cy	1,350	$ 24	$ 32,400	
[C]	Repave roadway	sy	600	$ 150	$ 90,000	
[C]	Replace curbs/gutters	lf	200	$ 33	$ 6,600	
	Transport and dispose of soil					
[C] fulltime	Collect soil stockpile waste profile sample for offsite disposal	ea	17	$ 35	$ 595	
[B] 3-Day TAT	Metals (EPA Method 6010)	ea	17	$ 180	$ 3,060	
[B] 3-Day TAT	Waste Extraction Test (STLC) (extraction only)	ea	17	$ 113	$ 1,921	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	2,880	$ 24	$ 69,120	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	3,600	$ 35	$ 126,000	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	720	$ 70	$ 50,400	
	Implement Land Use Control					
[C] share of cost; multiple sites	Prepare Site-Specific Addendum to LUCMRR	ls	60%	$ 10,000	$ 6,000	
[C] share of cost; multiple sites	Share of cost to prepare LUCMRR	ls	60%	$ 5,000	$ 3,000	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox -- Share of Cost	ls	60%	$ 24,000	$ 14,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells -- Share of Cost	ls	60%	$ 32,000	$ 19,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	60%	$ 102,000	$ 61,200	
	Subtotal Direct Costs					$ 1,101,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	60%	$ 120,000	$ 72,000	
[C] share of cost; multiple sites	Implementation Work Plan	ls	60%	$ 100,000	$ 60,000	
	Construction observation					
[E]	Resident engineer	wk	1	$ 5,950	$ 5,950	
[E]	Field engineer to coordinate disposal issues	wk	3	$ 5,950	$ 17,850	
[E]	Engineering technician	wk	3	$ 5,950	$ 17,850	
[E]	Geotechnical and compaction testing	wk	1.5	$ 3,868	$ 5,802	
[E]	Air monitoring	wk	2	$ 1,190	$ 2,380	
[E]	Field administrative support	wk	3	$ 5,950	$ 17,850	
[E]	Vehicles and equipment	wk	3	$ 1,547	$ 4,641	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	60%	$ 150,000	$ 90,000	
[E]	Archeology monitoring	wk	1.0	$ 4,760	$ 4,760	
						$ 299,000

Table B-12. Summary of Estimated Costs for Excavation with Backfill Option C (Complete Backfill) Building 231 Area (Including Former Building 271 Area), Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
[E]	Engineering Project Management	ls	10%			$ 30,000
	Subtotal Estimated Costs					$ 1,430,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 72,000
	Subtotal Estimated Costs					$ 1,502,000
[E]	*Contingencies*	ls	20%			$ 300,000
	Total Preliminary Estimated Capital Costs					**$ 1,802,000**
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	60%	$ 10,000	$ 6,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	60%	$ 4,000	$ 2,400	
						$ 8,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	60%	$ 22,000	$ 13,200	$ 13,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	60%	$ 14,000	$ 8,400	$ 8,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 45,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 45,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 1,847,000**

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Table B-13. Summary of Estimated Costs for Capping and Land Use Controls Building 228 Area Corrective Action Plan Building 207/231 Area, Presidio of San Francisco, California

Capping, Injection of Oxygen Release Product, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	**Task Description**	**Unit**	**Quantity**	**Unit Cost**	**Subtotal**	**Total** *(thousands)*
	CAPITAL COSTS					
	Inspect Existing Cover for Improvements and Repair					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
	Asphalt cap/capping improvements of paved areas					
[C]	Sawcut, demolish, recycle asphalt	sf	400	$ 4	$ 1,600	
[C]	Seal / repave asphalt	sf	400	$ 4	$ 1,600	
[A,B,C] share of cost; multiple sites	Indoor air monitoring, building inspection	ls	33%	$ 30,000	$ 9,900	
	Oxygen release product application in 2-inch diameter DPT borings					
[A]	Mobilize drill rig, crew, equipment and supplies	ls	1	$ 4,000	$ 4,000	
estimate	Oxygen Release Product Injection	day	3	$ 1800	$ 5,400	
estimate	Oxygen release product material	lb	375	$ 10	$ 3,750	
	Implement Land Use Control					
[C] share of cost	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[B;G] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 47,000
	Design and Construction Management					
	Engineering					
[E] share of cost	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	0.5	$ 5,950	$ 2,975	
[E]	Vehicles and equipment	wk	0.5	$ 1,547	$ 774	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeological Monitoring	wk	0.3	$ 4,760	$ 1,428	
						$ 42,000
[E]	Engineering Project Management	ls	10%			$ 4,000
	Subtotal Estimated Costs					$ 93,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 5,000
	Subtotal Estimated Costs					$ 98,000
[E]	*Contingencies*	ls	20%			$ 20,000
	Total Preliminary Estimated Capital Costs					**$ 118,000**

Table B-13. Summary of Estimated Costs for Capping and Land Use Controls Building 228 Area Corrective Action Plan Building 207/231 Area, Presidio of San Francisco, California

Capping, Injection of Oxygen Release Product, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	ANNUAL COSTS					
	In Situ Confirmation Sampling of Oxygen Release Product Remediation					
[A]	Mobilize CPT drill rig, crew, equipment and supplies	ls	1	$ 3,600	$ 3,600	
[A]	Collect in situ soil sample	ea	10	$ 62	$ 620	
[A]	Collect in situ groundwater sample	ea	4	$ 96	$ 384	
[B] 10-Day TAT	TPHg/BTEX/MTBE (EPA Method 8015/8021)	ea	16	$ 115	$ 1,840	
[B] 10-Day TAT	TPH-d/fo (EPA Method 8015)	ea	16	$ 75	$ 1,200	
[B] 10-Day TAT	VOCs (EPA Method 8260)	ea	16	$ 100	$ 1,600	
[B]	Data Validation (Independent 3rd Party)	ea	16	$ 34	$ 544	
[B]	Input analytical results into Presidio database	ea	16	$ 18	$ 288	
						$ 10,000
[G]	Annual Cap Inspection, Maintenance, Repair (Years 1-30)	ls	1	$ 500	$ 500	
	LUC Management					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 2,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Annual Groundwater Monitoring (Years 2-10)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 10 yrs @ 2.8%	*Years 1-10 Present Worth of Annual Costs*					$ 37,000
[G] 20 yrs @ 3%	*Years 11-30 Present Worth of Annual Costs*					$ 30,000
	Total Preliminary Estimated Present Worth of 30-Year Annual Costs					**$ 67,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 185,000**

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Table B-14. Summary of Estimated Costs for
Capping and Land Use Controls
Building 230 Area
Corrective Action Plan Building 207/231 Area, Presidio of San Francisco, California

Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Inspect Existing Cover for Improvements and Repair					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
	Asphalt cap/capping improvements of paved areas					
[C]	Sawcut, demolish, recycle asphalt	sf	3,000	$ 4	$ 12,000	
[C]	Seal / repave asphalt	sf	3,000	$ 4	$ 12,000	
[C]	Replace curbs/gutters	lf	10	$ 33	$ 330	
[C] share of cost; multiple sites	Indoor air monitoring, building inspection	ls	33%	$ 30,000	$ 9,900	
	Implement Land Use Control					
[C] share of cost	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[B;G] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 55,000
	Design and Construction Management					
	Engineering					
[E] share of cost	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[E] share of cost	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	2	$ 5,950	$ 11,900	
[E]	Vehicles and equipment	wk	2	$ 1,547	$ 3,094	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeological Monitoring	wk	0.3	$ 4,760	$ 1,428	
						$ 53,000
[E]	Engineering Project Management	ls	10%			$ 5,000
	Subtotal Estimated Costs					$ 113,000
[E]	*Legal and Administrative Costs*	ls	5%			$ 6,000
	Subtotal Estimated Costs					$ 119,000
[E]	*Contingencies*	ls	20%			$ 24,000
	Total Preliminary Estimated Capital Costs					**$ 143,000**

Table B-14. Summary of Estimated Costs for
Capping and Land Use Controls
Building 230 Area
Corrective Action Plan Building 207/231 Area, Presidio of San Francisco, California

Capping, Permanent Land Use Control, 10 Years Annual Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total *(thousands)*
	ANNUAL COSTS					
[G]	Annual Cap Inspection, Maintenance, Repair (Years 1-30)	ls	1	$ 500	$ 500	
	LUC Management -- Share of Cost (Years 1-30)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 2,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Annual Groundwater Monitoring (Years 2-10)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 10 yrs @ 2.8%	*Years 1-10 Present Worth of Annual Costs*					$ 27,000
[G] 20 yrs @ 3%	*Years 11-30 Present Worth of Annual Costs*					$ 30,000
	Total Preliminary Estimated Present Worth of 30-Year Annual Costs					**$ 57,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 200,000**

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Table B-15. Summary of Estimated Costs for Excavation with Backfill Option C (Complete Backfill) Building 230 Area, Presidio of San Francisco, California

Complete Backfill - Backfill and repave to match existing conditions, Temporary Land Use Control, 3 Years Groundwater Monitoring

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
	CAPITAL COSTS					
	Excavate Soil and Backfill					
[C] share of cost; multiple sites	Mobilize/demobilize excavation equipment, crew and supplies	ls	10%	$ 30,000	$ 3,000	
[C]	Erect and maintain temporary work area perimeter fence	ft	1200	$ 7	$ 8,400	
[C]	Sawcut, demolish, recycle asphalt	sf	4,800	$ 4	$ 19,200	
[C]	Excavate soil, stockpile, load in end-dump or backfill clean soils into excavation	cy	400	$ 10	$ 4,000	
[C] share of cost; multiple sites	Install / operate excavation dewatering system	ls	10%	$ 75,000	$ 7,500	
[C] share of cost; multiple sites	Profile Backfill Material	ls	10%	$ 8,400	$ 840	
[C] 80% of in-place cy for swell, paving	Backfill excavation - imported / offsite borrow source: procure, transport, place and compact	cy	320	$ 24	$ 7,680	
	Excavation Confirmation Sampling					
[C] part-time	Collect Soil Samples	ea	9	$ 90	$ 810	
[B] 3-Day TAT	TPHd/fo (EPA Method 8015)	ea	9	$ 113	$ 1,017	
[B] 3-Day TAT	PAHs (EPA Method 8270)	ea	9	$ 225	$ 2,025	
[B] 3-Day TAT	Pb (EPA Method 6010)	ea	9	$ 35	$ 315	
[B]	Data Validation (Independent 3rd Party)	ea	9	$ 34	$ 306	
[B]	Input analytical results into Presidio database	ea	9	$ 18	$ 162	
	Site Restoration					
[C]	Repave excavated area (asphalt)	sf	4800	$ 4	$ 19,200	
[C]	Replace curbs/gutters	lf	10	$ 33	$ 330	
	Transport and dispose of soil					
[C] part-time	Collect soil stockpile waste profile sample for offsite disposal	ea	1	$ 90	$ 90	
[B] 3-Day TAT	Metals (EPA Method 6010)	ea	1	$ 180	$ 180	
[B] 3-Day TAT	Waste Extraction Test (STLC) (extraction only)	ea	1	$ 113	$ 113	
[C] 1.5 tons/cy; 40%	Class II/III facility Daily Cover (non-hazardous waste)	ton	160	$ 24	$ 3,840	
[C] 1.5 tons/cy; 50%	Class II facility (non-hazardous waste)	ton	200	$ 35	$ 7,000	
[C] 1.5 tons/cy; 10%	Class I/II facility (non-RCRA hazardous waste)	ton	40	$ 70	$ 2,800	
	Hydropunch Groundwater Confirmation Sampling					
[A]	Mobilize CPT drill rig, crew, equipment and supplies	ls	1	$ 3,600	$ 3,600	
[A]	Collect in situ groundwater sample	ea	2	$ 96	$ 192	
[B] 10-Day TAT	TPH-d/fo (EPA Method 8015)	ea	2	$ 75	$ 150	
[B] 10-Day TAT	PAHs (EPA Method 8270)	ea	2	$ 150	$ 300	
[B]	Data Validation (Independent 3rd Party)	ea	2	$ 34	$ 68	
[B]	Input analytical results into Presidio database	ea	2	$ 18	$ 36	
	Implement Land Use Control					
[C] share of cost	Prepare Site-Specific Addendum to LUCMRR	ls	10%	$ 10,000	$ 1,000	
[C] share of cost	Share of cost to prepare LUCMRR	ls	10%	$ 5,000	$ 500	
	Conduct Pre-Construction Groundwater Monitoring (Year 1)					
[A, B] share of cost; Table 7	Monitor 11 wells for COCs/Arsenic/redox	ls	10%	$ 24,000	$ 2,400	
	Install New Groundwater Monitoring Wells					
[B, C] share of cost; Table 7	Install and sample 6 new wells	ls	10%	$ 32,000	$ 3,200	
[C] share of cost; Table 7	Abandon 57 Wells After Groundwater Monitoring -- Share of Cost	ls	10%	$ 102,000	$ 10,200	
	Subtotal Direct Costs					$ 110,000
	Design and Construction Management					
	Engineering					
[C] share of cost; multiple sites	Planning and Remedial Design	ls	10%	$ 120,000	$ 12,000	
[C] share of cost; multiple sites	Implementation Work Plan	ls	10%	$ 100,000	$ 10,000	
	Construction observation					
[E]	Resident engineer	wk	1	$ 5,950	$ 5,950	
[E]	Field engineer to coordinate disposal issues	wk	0.5	$ 5,950	$ 2,975	
[E]	Engineering technician	wk	0.5	$ 5,950	$ 2,975	
[E]	Geotechnical and compaction testing	wk	0.5	$ 3,868	$ 1,934	
[E]	Air monitoring	wk	0.5	$ 1,190	$ 595	
[E]	Field administrative support	wk	1	$ 5,950	$ 5,950	
[E]	Vehicles and equipment	wk	1	$ 1,547	$ 1,547	
[E] share of cost; multiple sites	Construction Completion Report - Large/Multiple Remedial Unit Chemical Spill Sites	ls	10%	$ 150,000	$ 15,000	
[E]	Archeology monitoring	wk	0.3	$ 4,760	$ 1,428	
						$ 60,000

Table B-15. Summary of Estimated Costs for Excavation with Backfill Option C (Complete Backfill) Building 230 Area, Presidio of San Francisco, California

Assumptions [Ref. Unit Costs Attachment]	Task Description	Unit	Quantity	Unit Cost	Subtotal	Total (thousands)
[E]	Engineering Project Management	ls	10%			$ 6,000
	Subtotal Estimated Costs					$ 176,000
	Legal and Administrative Costs	ls	5%			$ 9,000
	Subtotal Estimated Costs					$ 185,000
	Contingencies	ls	20%			$ 37,000
	Total Preliminary Estimated Capital Costs					**$ 222,000**
	ANNUAL COSTS					
	LUC Management -- Share of Cost (Years 1-3)					
[G] share of cost; multiple sites	Annual Administrative Cost of LUC	ls	10%	$ 10,000	$ 1,000	
[G] share of cost; multiple sites	Annualized Cost of 5-year Review	ls	10%	$ 4,000	$ 400	
						$ 1,000
	Conduct Post-Construction Quarterly Groundwater Monitoring (Year 1)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 22,000	$ 2,200	$ 2,000
	Conduct Post-Construction Semi-Annual Groundwater Monitoring (Years 2-3)					
[B, G] share of cost; Table 7	Monitor 10 wells for COCs -- Share of Cost	ls	10%	$ 14,000	$ 1,400	$ 1,000
[G] 3 yrs @ 2.8%	*Years 1-3 Present Worth of Annual Costs*					$ 6,000
	Total Preliminary Estimated Present Worth of 3-Year Annual Costs					**$ 6,000**
	TOTAL ESTIMATED REMEDIAL ALTERNATIVE COST					**$ 228,000**

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ATTACHMENT TO COST APPENDIX

UNIT COSTS MASTER REFERENCE TABLE, PRESIDIO OF SAN FRANCISCO, CALIFORNIA VERSION (1); JULY 2006

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

This Unit Costs Master Reference Table was established by the Trust to maintain a source of current unit rates and assumptions for preparing cost estimates associated with implementation of remedial & corrective actions at non-landfill & landfill sites under the Presidio Remediation Program. This table will be maintained and updated quarterly by the Trust based on actual costs incurred for ongoing and completed Presidio remediation projects.

The majority of unit rates & assumptions in this table were originally presented in *Table E-3, Derivation of Unit Rates, Final Revised Feasibility Study Report, Main Installation Sites, Presidio of San Francisco, California* (*EKI FS, 2003*). EKI FS unit rates were developed in 2000 and primarily derived from estimates and quotations provided by contractors and vendors and EKI's project team's experience on similar projects in the Bay Area at that time. These costs were evaluated by EKI's project team, which included Golder Associates (Golder) and DeSilva Gates Construction (De Silva Gates) based on site walks through selected Main Installation sites.

This table was developed as follows:

NEW UNIT COSTS AND ASSUMPTIONS

- Trust experience based on actual costs accrued since 2000
- Trust consultants' experience based on actual costs accrued since 2000
- Local contractor quotes, 2006
- ECHOS Environmental Remediation Cost Data — Unit Price & Assemblies, January 2006
- RS Means Environmental Remediation Estimating Methods, 2005 Edition

UPDATE OF UNIT COSTS FROM EKI FS

- Unit costs retained from the EKI FS were increased by a factor of 1.19 (19%) for Q2 (March 2006) based on the *Engineering News Record (ENR) Construction Cost Index (CCI)* for San Francisco, CA. Note: The ENR update factor for the current Quarter should be calculated from July 2000 (CCI of 7436) when costs were originally developed by EKI (and updated by the ENR factor in 2002 for the final EKI FS published in 2003).

RATES FOR NET PRESENT VALUE OF LONG TERM ANNUAL O&M COSTS

- The Net Present Value (NPV) of total estimated annual costs for the duration of operations & maintenance (O&M) activities are calculated assuming real discount rates published in *Circular No. A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. Appendix C, President's Federal Office of Management and Budget (OMB), January 2006*, updated yearly in January, and available online on the Federal government's website (www.whitehouse.gov). Real discount rates are applied to total annual costs for annual expenditures on project O&M durations of up to 30 years per USEPA's *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study (USEPA, 2000)*.

REFERENCES

- Trust Experience: Actual costs accrued based on Trust Remediation Program experience since 2000.
- Engineering News Record, Quarterly Cost Report, March 2006, published by McGraw Hill Construction. Construction Cost Index (CCI) updated quarterly and available online at ENR's website (www.enr.com).
- Environmental Cost Handling and Options Solutions (ECHOS) Cost Database, 12th Edition, 2006, published yearly in January by the Azimuth Group, Ltd: Environmental Remediation Cost Data — Unit Price & Assemblies. Note: Previously published yearly by RS Means as 2 separate hardcopy volumes, as of 2006, the ECHOS Cost Database contains both volumes and is now available only in downloadable electronic format (Acrobat Reader PDF) from the ECHOS website (www.echos-online.com).

REFERENCES (Cont'd)

- Environmental Remediation Estimating Methods, 2nd Edition (2005), RS Means, Reed Construction Data, previously published in 2000.
- Table E-3, Derivation of Unit Rates, EKI FS (2003): Where limited cost data from local contractors and vendors were available, unit rates were obtained from published cost estimating guides, including R.S. Means, Heavy Construction Cost Data, 2000 Edition ("Means"), R.S. Means, Environmental Remediation Cost Data - Unit Price, 2000 Edition ("ECHOS"), and R.S. Means, Environmental Remediation Cost Data - Assemblies, 2000 Edition ("ACB"). The unit rates obtained from Means, ECHOS, and ACB included bare costs plus contractor's overhead and profit. The base unit rates were adjusted using a multiplier to account for economic conditions in San Francisco (ENR CCI "%CHG"). Unit costs for Design and Construction Management Services were developed for Presidio Landfills and Miscellaneous Sites. These unit costs are believed to represent costs on average for Presidio sites of the same category. For some sites, specific costs may be higher (e.g., planning and permitting at Mountain Lake, geotechnical studies for capping alternatives) or lower (e.g., geotechnical studies for excavation) than the average.

ABBREVIATIONS & ACRONYMS

BAAQMD	Bay Area Air Quality Management District
BOE	Board of Equalization
CAP	Corrective Action Plan
CCI	Construction Cost Index
COC	Chemical of concern
CPT	Cone penetrometer
CQAP	Construction Quality Assurance Plan
CUL	Cleanup level
cy	cubic yard
DTSC	Department of Toxic Substances Control
ea	each
ECHOS	Environmental Cost Handling Options & Solutions
EKI	Erler & Kalinowski, Inc.
ENR	Engineering New Record
EPA	Environmental Protection Agency
ft	linear foot
hr	hour
H&S	Health and Safety
kwhr	kilowatt-hour
LEL	Lower explosive limit
ls	lump sum
MDL	Method Detection Limit
NPDES	National Pollutant Discharge Elimination System
NPS	U.S. Dept. of the Interior, National Park Service
O&M	Operations and maintenance
OVM	organic vapor meter
PPE	personal protective equipment
PVC	polyvinyl chloride (plastic)
QAPP	Quality Assurance Project Plan
RAB	Restoration Advisory Board
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
RWQCB	Regional Water Quality Control Board
sf / sy	square foot / square yard
STLC	Soluble Threshold Limit Concentration
TAT	Turnaround time
TCLP	Toxicity Characteristic Leaching Procedure
TTLC	Total Threshold Limit Concentration
WET	Waste Extraction Test
WP	Work Plan
yr	year

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

GUIDE TO COST ASSEMBLIES

CAPITAL COSTS
[A] ADDITIONAL SITE CHARACTERIZATION / PRE-REMEDIAL DESIGN INVESTIGATION
[B] SAMPLE ANALYSIS & MANAGEMENT
[C] NON-LANDFILL SITES REMEDIATION
[D] LANDFILL SITES REMEDIATION
[E] NON-LANDFILL SITES DESIGN AND CONSTRUCTION MANAGEMENT
[F] LANDFILL SITES DESIGN AND CONSTRUCTION MANAGEMENT
OPERATIONS & MAINTENANCE COSTS
[G] NON-LANDFILL SITES OPERATIONS AND MAINTENANCE
[H] LANDFILL SITES OPERATIONS AND MAINTENANCE

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
[A] ADDITIONAL SITE CHARACTERIZATION / PRE-REMEDIAL DESIGN INVESTIGATION				
PRE-CONSTRUCTION ARCHAEOLOGICAL / CULTURAL INVESTIGATION				
Prepare Work Plan, conduct field work, summary report	ls	--	Request site-specific quote	
ADDITIONAL SITE CHARACTERIZATION / PRE-REMEDIAL DESIGN INVESTIGATION				
PLANNING				
Prepare Additional Site Characterization Work Plan	ls	$15,000	Per field effort	Up to 10 borings. Multiple revisions of report to address comments. **(Trust Experience, 2006)**
Upgrade to Level C PPE/ Decontamination	ls	$800	Per day	**(Trust Experience, 2006)**
DRILL SOIL BORING AND SAMPLE SOIL				
Mobilize drill rig, crew, equipment and supplies	ls	$4,200	Per field effort	Mobe/demobe of drill rig, crew, equipment and supplies **(ECHOS 33 01 0101; 2006)**
Complete shallow soil borings with hand auger	ea	$238	Per sample location	1 technician collects 5 soil samples with hand equipment and logging
Perform concrete coring	ea	$417	Per sample location	3 holes
Complete soil borings with hollow stem auger drill rig	ea	$1,190	Per sample location	1 technician collects soil samples from up to 3 drilled borings per day
Log lithology of drilled borings	ea	$1,190	Per boring	1 geologist, 6 hr/boring
Collect soil sample	ea	$31	Per sample	1 technician, 8 hrs/day, collects and documents 20 soil samples
Analyze sample, validate data, manage and enter in Trust database	ea	varies	SEE [B] SAMPLE ANALYSIS AND MANAGEMENT	Data reporting in construction/closure report
CONSTRUCT GROUNDWATER MONITORING WELL				
Mobilize drill rig, crew, equipment and supplies	ls	$4,200	Per field effort	Mobe/demobe of drill rig, crew, equipment and supplies **(ECHOS 33 01 0101; 2006)**
Log lithology of boring for monitoring well	ea	$1,190	Per sample location	1 geologist, 6 hrs/well
Construct 4-inch PVC monitoring well	ea	$640	Per well	20 ft deep well, materials and labor **(ECHOS 33 23 0102; 2006)**
Sample and dispose of drill cuttings and development water	ea	$595	Per well	Local contractor quotation per well.
Develop monitoring well	ea	$417	Per well	1 geologist develops 3 wells in 10 hr day, plus $250 materials
GROUNDWATER / SURFACE WATER SAMPLING				
Sample monitoring wells or seeps	ea	$268	Per sample location	1 geologist samples 5 wells in 10 hr day, plus $250 of materials
Dispose of groundwater sampling residuals	ea	$452	Per sample event	1 technician disposes of water from 4 wells in 8 hr day, plus equipment
Analyze sample, validate data, manage and enter in Trust database	ea	varies	SEE [B] SAMPLE ANALYSIS AND MANAGEMENT	Data reporting in construction/closure report
DIRECT PUSH / IN SITU SOIL AND GROUNDWATER SAMPLING				
Mobilize CPT drill rig, crew, equipment and supplies	ls	$3,600	Per field effort	Mobe/demobe of drill rig, crew, equipment and supplies **(ECHOS 33 02 0640; 2006)**
CPT rig and sampling crew, supplies	ls	$3,600	Per day	Drill rig operating and sampling, punching, and supplies **(ECHOS 33 02 0619; 2006)**
Collect in situ groundwater sample	ea	$96	Per sample	Labor **(ECHOS 33 02 0647; 2006)**
Collect in situ soil sample	ea	$62	Per sample	Labor **(ECHOS 33 02 0648; 2006)**
Analyze sample, validate data, manage and enter in Trust database	ea	varies	SEE [B] SAMPLE ANALYSIS AND MANAGEMENT	Data reporting in construction/closure report
INDOOR AIR SAMPLING				
Mobilization, equipment rental	ls	$250	Per field effort	Mobe/demobe of crew, equipment rental and supplies (sample, summa canister) **(ECHOS 33 02 0345; 2006)**
Collect ambient air sample	ea	$1,750	Per sample	**(Trust Experience, 2006)**
Validate data, manage and enter in Trust database	ea	varies	SEE [B] SAMPLE ANALYSIS AND MANAGEMENT	Data reporting in construction/closure report

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
[B] SAMPLE ANALYSIS & MANAGEMENT				
DATA MANAGEMENT / DATA VALIDATION				
			Request new quote every 6 months	
Data Validation (Independent 3rd Party)				
GC Methods (EPA Methods 8015B, 8021A, 8081A, 8082)	ea	$25	Per sample	Hard copy and 2 CDs **(DataVal Inc; 4/2006)**
GC/MS Methods (EPA Methods (8260B, 8270C)	ea	$34	Per sample	Hard copy and 2 CDs **(DataVal Inc; 4/2006)**
HPLC Methods (EPA Methods 8310, 8330)	ea	$30	Per sample	Hard copy and 2 CDs **(DataVal Inc; 4/2006)**
Metals (EPA Methods 6010B, 6020, 7470A, 7471A)	ea	$38	Per sample	Hard copy and 2 CDs **(DataVal Inc; 4/2006)**
General Chemistry	ea	$7	Per sample	Hard copy and 2 CDs **(DataVal Inc; 4/2006)**
Electronic Data Deliverable (Additional Copy for Geotracker)	ea	$50	Per laboratory report	CD **(Curtis & Tompkins; 4/2006)**
Input analytical result into Presidio database	ea	$18	Per sample	Trust database specialist inserts validated electronic data deliverables into database.
LABORATORY ANALYSIS				
		Request new quote every 6 months. Standard 10-Day TAT: Field Investigations & Groundwater Monitoring 1-3 Day TAT: Contingency Actions & Confirmation Sampling		Standard TAT = 10 business days. % cost increase for expedited analysis: 5 Day TAT = 125%, 3-Day TAT = 150%; 2-Day TAT = 175%; 1-Day TAT = 200%.
SOIL & WATER SAMPLES		For Seep / Surface Water sample analysis, request quote from Columbia / laboratory that can meet MDLs lower than standard groundwater analysis MDLs		EPA Level III / 10% Level IV data report package: **(Curtis & Tompkins; 4/2006)**
Organics				
TPHg (EPA Method 8015M)	ea	$50/ $63/ $75/ $88/ $100	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
TPHd/mo/fo, silica gel cleanup (EPA Method 8015M)	ea	$75/ $94/ $113/ $131/ $150	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Oil and grease (EPA Method 413.1, Standard Methods 5520F)	ea	$50/ $63/ $75/ $88/ $100	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
VOCs (EPA Method 8010)	ea	$75/ $94/ $113/ $131/ $150	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
VOCs (EPA Method 8260B)	ea	$100/ $125/ $150/ $175/ $200	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
BTEX and MTBE (EPA Method 8021 Mod.)	ea	$65/ $81/ $98/ $114/ $130	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
BTEX only (EPA Method 8021 Mod.)	ea	$55/ $69/ $83/ $96/ $110	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
MTBE only (EPA Method 8021 Mod.)	ea	$55/ $69/ $83/ $96/ $111	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
SOCs (EPA Method 8270C)	ea	$200/ $250/ $300/ $350/ $400	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
PAHs (EPA Method 8310 or 8270-SIM)	ea	$150/ $188/ $225/ $263/ $300	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Pesticides and PCBs (EPA Methods 8081A/8082)	ea	$205/ $256/ $308/ $360/ $410	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Pesticides only (EPA Method 8081A)	ea	$135/ $169/ $203/ $236/ $270	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
PCBs only (EPA Method 8082)	ea	$70/ $88/ $105/ $123/ $140	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Chlorinated herbicides (EPA Method 8151A)	ea	$195/ $244/ $293/ $341/ $390	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Inorganics				
Title 22 metals (EPA Method 6010/7000)	ea	$120/ $150/ $180/ $210/ $240	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Individual Metals (e.g., arsenic, copper, lead, zinc) (EPA Method 6010)	ea	$23/ $30/ $35/ $42/ $50	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Mercury (EPA Method 7471)	ea	$35/ $44/ $53/ $61/ $70	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Cyanide (EPA Methods 9010B or 9012A)	ea	$40/ $50/ $60/ $70/ $80	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Hexavalent chromium (EPA Method 7196)	ea	$40/ $50/ $60/ $70/ $80	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Other Parameters				
Dry weight %	sample	$10/ $13/ $15/ $18/ $20	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
General minerals	ea	$200/ $250/ $300/ $350/ $400	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Dissolved sulfides (EPA Method 376.2)	ea	$30/ $38/ $45/ $53/ $60	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Total suspended solids (EPA Method 160.2)	ea	$20/ $25/ $30/ $35/ $40	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Chemical oxygen demand (EPA Method 410.4)	ea	$25/ $31/ $38/ $44/ $50	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Phenols (EPA Method 8040)	ea	$40/ $50/ $60/ $70/ $80	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Flashpoint (EPA Method 1010)	ea	$20/ $25/ $30/ $35/ $40	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
pH (EPA Method 150.1)	ea	$12/ $15/ $18/ $21/ $24	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
Asbestos (PLM)	ea	$34/ $43/ $51/ $60/ $68	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	
AIR SAMPLES				
Principal Organic Haz. Constituents (EPA Methods TO-14/30/5041/8260	ea	$275/ $344/ $413/ $481/ 550	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	**(ECHOS 33 02 1802; 2006)**
Total Volatile Hydrocarbons and BTEX (EPA Methods 5041/8021B/8015	ea	90/ $113/ $135/ $158/ $180	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	**(ECHOS 33 02 1807; 2006)**
VOCs (EPA Method TO-14)	ea	113/ $141/ $170/ $198/ $226	10-Day/ 5-Day/ 3-Day/ 2-Day/ 1-Day TAT	**(ECHOS 33 02 1834; 2006)**
WASTE PROFILE FOR OFFSITE DISPOSAL OF SOIL & WATER				
Waste Extraction Test / Sample preparation	ea	$75/ $94/ $113/ $131/ $150	Extraction procedure only.	
Analyze WET/TCLP Extractant for chemical of concern	ea	varies	Analyze extractant for COCs. Compare concentrations to TTLCs / STLCs / Facility Acceptance Criteria.	See Quotes above per sample

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
[C] NON-LANDFILL SITES REMEDIATION				
SOIL REMEDIATION ACTIVITIES				
EXCAVATION MOBILIZATION / SITE PREPARATION				
Mobilize/demobilize excavation equipment, crew and supplies	ls	$10,000 to $100,000	10% of direct costs up to $200,000. 5% of direct costs greater than $200,000.	Direct costs $100,000 for smaller sites. Excavation crew, equipment, supplies. CCI factor of 1.26 applied for San Francisco, CA **(ENR CCI; RS Means EREM, Figure 62.8; 2006)**
Survey and stake work area	ls	$915	Per day	2-person crew **(ECHOS; 99 04 0201; 2006)**
Erect and maintain temporary work area perimeter fence	ft	$7	Work area enclosure	Temporary 6-ft chain link construction fencing for site security **(ECHOS; 99 04 0302; 2006)**
DEMOLISH EXISTING IMPROVEMENTS				
Relocate overhead utilities, storm drains, street lights, miscellaneous utilities	ls	varies	Prepare site-specific estimate.	See **(ECHOS 17 02 04; 2006)**
Demolish buildings, structures	ls	varies	Prepare site-specific estimate.	See **(ECHOS 17 02 04; 2006)**
Destroy groundwater monitoring well / piezometer	ea	$1,785		Local contractor quotation.
Sawcut, demolish, recycle asphalt	sf	$4		4-inch thick asphalt **(ECHOS 17 02 0203; 2006).**
Sawcut, demolish, recycle concrete	sf	$10		0.5 to 2-ft thick unreinforced concrete **(ECHOS 17 02 0210; 2006).**
Remove medium to large size trees	ea	$1,250	Typical. Request site-specific quote.	**(Trust experience; 2006)**
EXCAVATE SOIL, LOAD, BACKFILL, PLACE AND COMPACT SOIL / COVER				
Exploratory trenching, backfill, and compaction	cy	$5		Backhoe / hydraulic excavator **(ECHOS 17 03 0255; 2006).**
Excavate soil, stockpile, load in end-dump truck or backfill clean soils into ex	cy	$10	Multiply total "in place" cy to be excavated (bank cubic yards) by factor of 1.4 to determine excavated volume (loose cubic yards).	Backhoe / hydraulic excavator **(ECHOS 17 03 0255; 2006), combined EKI FS costs for double handling, (Trust experience; 2006).**
Move soil (onsite 'double' handling)	cy	$2	Multiply total "in place" cy to be excavated (bank cubic yards) by factor of 1.4 to determine excavated volume (loose cubic yards).	Backhoe / hydraulic excavator **(ECHOS 17 03 0255; 2006), combined EKI FS costs for double handling, (Trust experience; 2006).**
Profile Backfill material	sample	$3,000 minimum / $1,800	$3,000 minimum. $1,800 per sample up to 5,000 cy. Profiling sources over 5,000 cy should be estimated on a site specific basis.	**(Trust experience; 2006)**
Backfill excavation -- Imported / Offsite borrow source: procure, transport, place and compact	cy	$24		Standard backfill material **(Trust experience; 2006).**
Backfill excavation -- Onsite borrow source: procure, transport, place and compact	cy	$10	Consult Trust on availability and location.	Clean overburden from Presidio sources **(Trust Experience, 2006).**
Install / operate excavation dewatering system	ls	$10,000 to $30,000	Varies typically from 10% to % 30 of excavation direct costs. Request site-specific contractor quote.	Direct excavation costs $100,000 for smaller sites. Pumping and holding tank equipment, supplies, disposal management. CCI factor of 1.26 applied for San Francisco, CA **(ECHOS 17 03 10; ENR CCI; RS Means EREM, Figure 62.8; 2006)**
Install excavation shoring / piling system	ls	varies	Varies depending on depth, size of excavation and site location. Request site-specific contractor quote for excavations deeper than 5 feet bgs.	**See (ECHOS 17 03 10; 2006)**
Hand excavate open area	cy	$80		**(Trust experience; 2006)**
Hand excavate limited access area	cy	$250		**(Trust experience; 2006)**
Hand screen archaeological artifacts	cy	$85		**(Trust experience; 2006)**
SOIL CONFIRMATION / WASTE PROFILE SAMPLING				
Collect excavation soil confirmation sample	ea	$35 / $90	Per sample: full time sampling / follow-up sampling. Collect minimum of 1 sample per sidewall and excavation bottom on 50-ft center or using Best Professional Judgment.	1 technician, 8 hrs/day, collects and documents 20 soil samples / 1 technician, 4 hrs/day, collects and documents <4 soil samples
Collect soil stockpile waste profile sample for offsite disposal	ea	$35 / $90	Per sample: full time sampling / follow-up sampling. Collect 1 sample per 500 cy stockpile; 4-point composite	2 technician, 8 hrs/day, collects and documents 20 soil samples / 1 technician, 4 hrs/day, collects and documents <4 soil samples
Analyze sample, validate data, manage and enter in Trust database	ea	varies	SEE [B] SAMPLE ANALYSIS AND MANAGEMENT	--

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
APPLICATION OF OXYGEN RELEASE PRODUCT				
Mix product in excavation bottom, place layer of gravel prior to backfill	ls	varies	Request site-specific contractor quote.	--
TRANSPORTATION AND OFFSITE DISPOSAL OF SOIL				
			1.7 tons per cy for typical moist/dense soils 1.4 tons per cy for typical dry unconsolidated soils.	
Class II / III facility Daily Cover (non-hazardous waste)	ton	$24	Acceptance guideline: 'Clean' overburden (no CULs exceeded).	Includes BOE generator fees **(Trust experience; 2004).**
Class II facility (non-hazardous waste)	ton	$35	Acceptance guideline: COC concentrations < TTLC.	Includes BOE generator fees **(Trust experience; 2004).**
Class I / II facility (non-RCRA hazardous waste)	ton	$70	Acceptance guideline: COC concentrations > TTLC / < STLC.	Includes BOE generator fees **(Trust experience; 2004).**
Class I facility (RCRA hazardous waste)	ton	$110	Acceptance guideline: COC concentrations > TTLC / > STLC up to 150%.	Includes BOE generator fees. **(Chem Waste Management; 2005).**
Class I facility (RCRA hazardous waste requiring stabilization)	ton	$310	Acceptance guideline: COC concentrations > TTLC / > STLC by > 150%.	Includes BOE generator fees. **(Chem Waste Management; 2005).**
SITE RESTORATION / INSPECTION OF EXISTING COVER				
Replace Improvements				
Overhead utilities, storm drains, street lights, miscellaneous utilities	ls	varies	Request site-specific contractor quote.	See **(ECHOS 17 02 04; 2006)**
Asphalt	sf	$4		4-inch thick asphalt. Means 02740-315-0020.
Concrete	sf	$10		0.5 to 2-ft thick unreinforced concrete **(ECHOS 17 02 0210; 2006).**
Curbs and gutters	ft	$33		Standard streetside concrete. Means 02740-315-0020.
Roadway	sy	$150 to $300	High capacity / low capacity	High capacity road, 34-foot wide traveled way. Lower range price for lower volume residential roads. **(Trust experience; 2006).** Also see **(ECHOS 18 01 0302; 2006).**
Replace Groundwater Monitoring Well				
Mobilize drill rig, crew, equipment and supplies	ls	$4,200	Per field effort	Mobe/demobe of drill rig, crew, equipment and supplies **(ECHOS 33 01 0101; 2006)**
Log lithology of boring for monitoring well	ea	$1,190	Per sample location	1 geologist, 6 hrs/well
Construct 4-inch PVC monitoring well	ea	$640	Per well	20 ft deep well, materials and labor **(ECHOS 33 23 0102; 2006)**
Sample and dispose of drill cuttings and development water	ea	$595	Per well	Local contractor quotation per well.
Develop monitoring well	ea	$417	Per well	1 geologist develops 3 wells in 10 hr day, plus $250 materials
Replace Vegetation / Erosion Control				
Install 40-mil geotextile fabric to separate underlying soil / revegation horizon	sf	$1.2		Golder project experience. ECHOS 33-08-0543.
Seed with athletic field mix	acre	$1,428		Seed with grass for athletic field, tractor spread. Golder project experience.
Stabilization/erosion control for steep slopes	acre	$14,506		Golder project experience. ECHOS 33-08-0543.
VMP NATIVE PLANT ZONES			Minimum 1/4 acre cost for large sites; share costs for multiple small sites	Revegetation installation, irrigation to establish **(Trust experience; 2004).**
In Serpentine Soils	acre	$89,500		
In Colma Soil	acre	$52,200		
In Dune Sand	acre	$52,200		
VMP Historic Forest Zone	acre	$58,000		
VMP Landscape Zone	acre	$43,500		
Parking lot landscape strips	sf	$2		
Cover with erosion control blanket on steep slopes	sf	$1		Revegetation mat, erosion control on steep slopes. Golder project experience.

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
Inspect Existing Cover for Improvements and Repair				
Outdoor inspection of asphalt / concrete surface structures for weathering/cracks	ls	$250	Per day	Field engineer, 10 hrs/day **(ECHOS 99 11 0402; 2006)**
Indoor inspection of foundation for cracks/utility conduits	ls	$500	Per day	Field engineer, 10 hrs/day **(ECHOS 99 11 0202; 2006)**
Indoor air sampling	ls	varies	SEE [A] ADDITIONAL SITE CHARACTERIZATION	
Seal / repave asphalt	sf	$4		4-inch thick asphalt. Means 02740-315-0020.
Seal / replace concrete	sf	$10		0.5 to 2-ft thick unreinforced concrete **(ECHOS 17 02 0210; 2006).**
Inspect and maintain existing cover after improvements	ls	varies	SEE [G] OPERATIONS AND MAINTENANCE	
IMPLEMENT LAND USE CONTROL / NOTIFICATION (LUC/LUN) FOR RESIDUAL CONTAMINATION				
			Sites on Area A / B boundary: Include costs for both Area A and Area B	
AREA B				
Prepare Site-Specific Addendum to LUCMRR for Area B	ls	$2,500 / $5,000 /$10,000	Smaller sites nearby others / Medium sites / Large isolated sites	Report preparation, entry in Trust LUCMRR GIS system. **(Trust experience; 2005)**
Share of cost to prepare LUCMRR for Area B	ls	$5,000	Per site	Report preparation, entry in Trust LUCMRR GIS system. **(Trust experience; 2005)**
Maintain LUC/LUN for Area B	ls	varies	SEE [G] OPERATIONS AND MAINTENANCE	
AREA A				
Prepare Site-Specific LUC/LUN Report for Area A	ls	$2,500 / $5,000 /$10,000	Smaller sites nearby others / Medium sites / Large isolated sites	Equivalent costs for Area B **(Trust experience; 2005)**
Share of cost to prepare LUC/LUN Report for Area A	ls	$5,000	Per site	Equivalent costs for Area B **(Trust experience; 2005)**
Maintain LUC/LUN for Area A	ls	varies	SEE [G] OPERATIONS AND MAINTENANCE	
[D] LANDFILL SITES REMEDIATION				
LANDFILL EXCAVATION ACTIVITIES				
MOBILIZATION / SITE PREPARATION				
Mobilize/demobilize excavation equipment, crew and supplies	ls	$100,000	5% of direct costs greater than $200,000.	Excavation crew, equipment, supplies. CCI factor of 1.26 applied for San Francisco, CA **(ENR CCI; RS Means EREM, Fig 62.8; 2006)**
Survey and stake landfill area	acre	$1,785		Surveying control per acre. Golder project experience.
Erect and maintain temporary work area perimeter fence	ft	$7	Work area enclosure	Temporary 6-ft chain link construction fencing for site security **(ECHOS; 99 04 0302; 2006)**
DEMOLISH EXISTING IMPROVEMENTS				
Rip and remove debris from top 2 feet and stockpile on-site	cy	$3		200 hp bulldozer. Means 02315-800-1500.
Screen soil from debris and stockpile on-site	cy	$6		DeSilva Gates quotation.
Demolish, remove, and recycle concrete foundations	cy	$179		Removal and recycling of subsurface foundations. Trust contractor estimate.
Mobilize concrete crushing equipment to site	ls	$11,900		10,000 cy minimum volume to be crushed. DeSilva Gates quotation.
Crush concrete removed from debris	cy	$10		On-site concrete crushing. DeSilva Gates quotation.
Destroy groundwater monitoring well / piezometer	ea	$1,785		Local contractor quotation.
CLEAR VEGETATION				
Clear, grub, grind brush, dispose of chips off-site	acre	$8,925		Cut and chip medium size brush. ECHOS 17-01-0107.
Remove medium to large size trees	ea	$1,250	Typical. Request site-specific quote.	**(Trust experience; 2006)**
Till grass into landfill surface	acre	$952		Brush mowing, heavy density. Means. 02230-220-1080.

UNIT COSTS MASTER REFERENCE TABLE
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TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
EXCAVATE SOIL, LOAD, BACKFILL, PLACE AND COMPACT SOIL / COVER				
Exploratory trenching, backfill, and compaction	cy	$5		Backhoe / hydraulic excavator **(ECHOS 17 03 0255; 2006).**
Excavate soil, stockpile, load in end-dump truck or backfill clean soils into excavation	cy	$10	Multiply total "in place" cy to be excavated (bank cubic yards) by factor of 1.4 to determine excavated volume (loose cubic yards).	Backhoe / hydraulic excavator **(ECHOS 17 03 0255; 2006), combined EKI FS costs for double handling, (Trust experience; 2006).**
Move soil (onsite 'double' handling)	cy	$2	Multiply total "in place" cy to be excavated (bank cubic yards) by factor of 1.4 to determine excavated volume (loose cubic yards).	Backhoe / hydraulic excavator **(ECHOS 17 03 0255; 2006), combined EKI FS costs for double handling, (Trust experience; 2006).**
Profile Backfill material	sample	$3,000 minimum / $1,800	$3,000 minimum. $1,800 per sample up to 5,000 cy. Profiling sources over 5,000 cy should be estimated on a site specific basis.	**(Trust experience; 2006)**
Backfill excavation -- Imported / Offsite borrow source: procure, transport, place and compact	cy	$24		Standard backfill material **(Trust experience; 2006).**
Backfill excavation -- Onsite borrow source: procure, transport, place and compact	cy	$10	Consult Trust on availability and location.	Clean overburden from Presidio sources **(Trust Experience, 2006).**
Install / operate excavation dewatering system	ls	$10,000 to $30,000	Varies typically from 10% to %30 of excavation direct costs. Request site-specific contractor quote.	Direct excavation costs $100,000 for smaller sites. Pumping and holding tank equipment, supplies, disposal management. CCI factor of 1.26 applied for San Francisco, CA **(ECHOS 17 03 10; ENR CCI; RS Means EREM, Figure 62.8; 2006)**
Install excavation shoring / piling system	ls	varies	Varies depending on depth, size of excavation and site location. Request site-specific contractor quote for excavations deeper than 5 feet bgs.	**See (ECHOS 17 03 10; 2006)**
Hand excavate open area	cy	$80		**(Trust experience; 2006)**
Hand excavate limited access area	cy	$250		**(Trust experience; 2006)**
Hand screen archaeological artifacts	cy	$85		**(Trust experience; 2006)**
SOIL CONFIRMATION / WASTE PROFILE SAMPLING				
Collect excavation soil confirmation sample	ea	$35 / $90	Per sample: full time sampling / follow-up sampling. Collect minimum of 1 sample per sidewall and excavation bottom on 50-ft center or using Best Professional Judgment.	1 technician, 8 hrs/day, collects and documents 20 soil samples / 1 technician, 4 hrs/day, collects and documents <4 soil samples
Collect soil stockpile waste profile sample for offsite disposal	ea	$35 / $90	Per sample: full time sampling / follow-up sampling. Collect 1 sample per 500 cy stockpile; 4-point composite	2 technician, 8 hrs/day, collects and documents 20 soil samples / 1 technician, 4 hrs/day, collects and documents <4 soil samples
Analyze sample, validate data, manage and enter in Trust database	ea	varies	SEE [B] SAMPLE ANALYSIS AND MANAGEMENT	--
TRANSPORTATION AND OFFSITE DISPOSAL OF SOIL				
			1.7 tons per cy for typical moist/dense soils 1.4 tons per cy for typical dry unconsolidated soils.	
Class II / III facility Daily Cover (non-hazardous waste)	ton	$24	Acceptance guideline: 'Clean' overburden (no CULs exceeded).	Includes BOE generator fees **(Trust experience; 2004).**
Class II facility (non-hazardous waste)	ton	$35	Acceptance guideline: COC concentrations < TTLC.	Includes BOE generator fees **(Trust experience; 2004).**
Class I / II facility (non-RCRA hazardous waste)	ton	$70	Acceptance guideline: COC concentrations > TTLC / < STLC.	Includes BOE generator fees **(Trust experience; 2004).**
Class I facility (RCRA hazardous waste)	ton	$110	Acceptance guideline: COC concentrations > TTLC / > STLC up to 150%.	Includes BOE generator fees. **(Chem Waste Management; 2005).**
Class I facility (RCRA hazardous waste requiring stabilization)	ton	$310	Acceptance guideline: COC concentrations > TTLC / > STLC by > 150%.	Includes BOE generator fees. **(Chem Waste Management; 2005).**
Recycle bulk asphalt	ton	$15		2 tons per cy. **(EKI; Landfills 8 & 10 FS, 2005)**
Recycle concrete debris	ton	$12		3 tons per cy. **(EKI; Landfills 8 & 10 FS, 2005)**

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
LANDFILL SITE RESTORATION / COVER AND COLLECTION SYSTEMS INSTALLATION ACTIVITIES				
Mobilization / Site Preparation				
Mobilize/demobilize excavation equipment and supplies	ls	$20,000	10% of direct costs up to $200,000. 5% of direct costs greater than $200,000.	Direct costs $400,000 for lanfill sites. Excavation crew, equipment, supplies. CCI factor of 1.26 applied for San Francisco, CA **(ENR CCI; RS Means EREM, Figure 62.8; 2006)**
Construct Interceptor Drain System				
Excavate trench for subsurface drainage system	cy	$5.2		1 foot wide excavation to 15 feet below grade. Means 02315-900-0910.
Purchase and install textured 40-mil polyethylene geomembrane	sf	$1.2		Install on landfill side of trench. Golder project experience. ECHOS 33-08-0543.
Install interceptor drain system	ft	$1.5		4 inch diameter perforated drainage pipe. Means 02620-265-0040.
Import and place crushed rock or aggregate	cy	$27		Means 03060-110-0850.
Place and compact trench backfill with excavated material	cy	$2		Reusing trench spoils as backfill material. DeSilva Gates quotation.
Install Groundwater Extraction System				
Construct 4-inch PVC extraction wells	ea	$3,570		20 ft deep well, local contractor quotation.
Groundwater extraction pump with controls	ea	$3,570		1/3 hp, 230 V, controls, probe. ECHOS 33-23-0601
Excavate trench for conveyance piping	cy	$5.2		1 foot wide excavation to 15 feet below grade. Means 02315-900-0910.
Install conveyance piping	ft	$1.5		4 inch diameter pipe. Means 02620-265-0040.
Extracted Water Discharge				
Install manhole and sanitary sewer connection	ea	$11,900		Excavation and backfill. DeSilva Gates quotation.
Install rip-rap spillway to reduce water velocity and distribute flow	cy	$71		Labor to position. DeSilva Gates quotation.
Excavate trench for subsurface drainage system	cy	$5.2		Excavation to 15 feet below grade. Means 02315-900-0910.
Purchase and install textured 40-mil polyethylene geomembrane	sf	$1.2		Install on landfill side of trench. Golder project experience. ECHOS 33-08-0543.
Install Vegetative Cover				
Grade and compact 2-ft foundation layer	cy	$2.7		200 hp bulldozer. Means 02315-410-4040.
Import, place, and compact backfill soil layer	cy	$24		Standard backfill material. DeSilva Gates quotation.
Import and place 1 foot topsoil layer	cy	$36		Plant-supporting topsoil material. DeSilva Gates quotation.
Cover with erosion control blanket on steep slopes	sf	$1		Revegetation mat, erosion control on steep slopes Golder project experience.
Seed with athletic field mix	acre	$1,428		Seed with grass for athletic field, tractor spread. Golder project experience.
Replace Vegetation / Erosion Control				
Install 40-mil geotextile fabric to separate underlying soil / revegation horizon	sf	$1.2		Golder project experience. ECHOS 33-08-0543.
Stabilization/erosion control for steep slopes	acre	$14,506		Golder project experience. ECHOS 33-08-0543.
Athletic field seed mix	acre	$1,428		Seed with grass for athletic field, tractor spread. Golder project experience.
VMP NATIVE PLANT ZONES			Minimum 1/4 acre cost for large sites; share costs for multiple small sites	Revegetation installation, irrigation to establish **(Trust experience; 2004).**
In Serpentine Soils	acre	$89,500		
In Colma Soil	acre	$52,200		
In Dune Sand	acre	$52,200		
VMP Historic Forest Zone	acre	$58,000		
VMP Landscape Zone	acre	$43,500		
Parking lot landscape strips	sf	$2		
Cover with erosion control blanket on steep slopes	sf	$1		Revegetation mat, erosion control on steep slopes, Golder project experience.

UNIT COSTS MASTER REFERENCE TABLE

Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
Install Low-Permeability Cover				
Grade and compact 2-ft foundation layer	cy	$3		200 hp bulldozer, Means 02315-410-4040.
Import and install 0.25-ft sand layer	cy	$24		Standard construction sand, DeSilva Gates quotation.
Purchase and install textured 40-mil polyethylene geomembrane	sf	$1		Golder project experience, ECHOS 33-08-0543.
Purchase and install geocomposite drainage net (1 side)	sf	$1		Drainage net, heat bonded 1 side, Golder project experience, ECHOS 33-08-0512.
Purchase and install geocomposite drainage net (2 sides)	sf	$1		Drainage net, heat bonded 2 sides, Golder project experience, ECHOS 33-08-0512 (also used for gas collection layer).
Purchase and install geosynthetic clay liner	sf	$1		Geosynthetic clay liner, ECHOS 33-08-0520.
Install drainage ditch at perimeter of cover system for surface water run-on	ft	$36		Concrete drainage ditch, 3 feet wide, DeSilva Gates quotation.
Construct Landfill Gas Control and Monitoring System				
Install passive landfill gas biofiltration treatment system	ls	$59,500		Landfill gas treatment if need is confirmed as part of final design, Golder project experience.
Install nested landfill gas probes, 40 ft deep (3 probes per boring)	ea	$2,618		Golder project experience.
Replace Improvements				
Overhead utilities, storm drains, street lights, miscellaneous utilities	ls	varies	Prepare site-specific estimate.	See **(ECHOS 17 02 04; 2006)**
Asphalt	sf	$4		4-inch thick asphalt, Means 02740-315-0020.
Concrete	sf	$10		0.5 to 2-ft thick unreinforced concrete **(ECHOS 17 02 0210; 2006).**
Curbs and gutters	ft	$33		Standard streetside concrete, Means 02740-315-0020.
Roadway	sy	$150 to $300	High capacity / low capacity	High capacity road, 34-foot wide traveled way. Lower range price for lower volume residential roads. (**Trust experience: 2006**). Also see **(ECHOS 18 01 0302; 2006).**
Replace Groundwater Monitoring Well				
Mobilize drill rig, crew, equipment and supplies	ls	$4,200	Per field effort	Mobe/demobe of drill rig, crew, equipment and supplies **(ECHOS 33 01 0101; 2006)**
Log lithology of boring for monitoring well	ea	$1,190	Per sample location	1 geologist, 6 hrs/well
Construct 4-inch PVC monitoring well	ea	$640	Per well	20 ft deep well, materials and labor **(ECHOS 33 23 0102; 2006)**
Sample and dispose of drill cuttings and development water	ea	$595	Per well	Local contractor quotation per well.
Develop monitoring well	ea	$417	Per well	1 geologist develops 3 wells in 10 hr day, plus $250 materials
IMPLEMENT LAND USE CONTROL / NOTIFICATION (LUC/LUN) FOR RESIDUAL CONTAMINATION				
			Sites on Area A / B boundary: Include costs for both Area A and Area B	
AREA B				
Prepare Site-Specific Addendum to LUCMRR for Area B	ls	$2,500 / $5,000 /$10,000	Smaller sites nearby others / Medium sites / Large isolated sites	Report preparation, entry in Trust LUCMRR GIS system. **(Trust experience: 2005)**
Share of cost to prepare LUCMRR for Area B	ls	$5,000	Per site	Report preparation, entry in Trust LUCMRR GIS system. **(Trust experience: 2005)**
Maintain LUC/LUN for Area B	ls	varies	**SEE [H] OPERATIONS AND MAINTENANCE**	
AREA A				
Prepare Site-Specific LUC/LUN Report for Area A	ls	$2,500 / $5,000 /$10,000	Smaller sites nearby others / Medium sites / Large isolated sites	Equivalent costs for Area B **(Trust experience: 2005)**
Share of cost to prepare LUC/LUN Report for Area A	ls	$5,000	Per site	Equivalent costs for Area B **(Trust experience: 2005)**
Maintain LUC/LUN for Area A	ls	varies	**SEE [H] OPERATIONS AND MAINTENANCE**	

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
[E] NON-LANDFILL SITES DESIGN AND CONSTRUCTION MANAGEMENT				
Planning, Remedial Design Implementation Documents				
Planning and Remedial Design	ls	$25,000	Small remedial unit or site. Prepare site-specific quote for multiple/large sites.	Orientation of engineering design firm, site surveying, coordination with Trust utility department, coordination with Trust and NPS stakeholders. Preparation of Remedial Design Plans and Specifications for bidding and support in bidding and award. Includes meetings and revisions to Remedial Design Plans and Specifications to respond to comments from Trust, NPS, RAB, and regulatory agencies. **(MACTEC experience, miscellaneous RAP/CAP sites; 2006).**
Implementation Work Plan	ls	$20,000 / $115,000	Small remedial unit or site / large remedial unit or site. Prepare site-specific quote.	The Work Plan (WP) will complement the Remedial Design Plans and Specifications and include Standard Operating Procedures in accordance with the Presidio QAPP (Soil Sampling, Groundwater Sampling, General Equipment Decontamination, Packaging and Shipping Samples), and provide sufficient detail in combination with the Final CAP or RAP and Trust guidance to develop Remedial Design Plans and Specifications for bidding. **(MACTEC experience, miscellaneous RAP/CAP sites; 2006) / (Trust experience; 2006).**
Appendices to Implementation Work Plan	ea	$1,000 / $5,000	Per Appendix for small remedial unit or site. Prepare site-specific quote.	Each WP may include the following Appendices: 1) Health & Safety Plan; 2) Construction Quality Assurance Plan Each WP may also include the following Appendices depending on site-specific conditions: 3) Dewatering Plan; 4) Traffic & Signage Plan; 5) Air Monitoring Plan; 6) Storm Water Pollution Prevention Plan; 7) Erosion Control and Monitoring Plan; 8) Cultural Resources Protection Plan; 9) Confirmation Sampling Plan; 10) Groundwater Monitoring Plan **(MACTEC experience, miscellaneous RAP/CAP sites; 2006).**
Construction Observation				
Resident engineer / site supervisor	week	$5,950		1 engineer, 10 hr/day, 5 day/week throughout construction.
Field engineer to coordinate disposal issues	week	$5,950		1 engineer, 10 hr/day, 5 day/week throughout construction to
Engineering technician	week	$3,570		1 engineer, 4 hr/day, 5 day/week throughout construction.
Field administrative support	week	$2,380		1 engineer, 4 hr/day, 5 day/week throughout construction.
Field vehicles and equipment	week	$1,547		Vehicle, field supplies, photographs, OVM, and other H&S equipment.
Geotechnical and compaction testing	week	$3,868		1 technician, 10 hr/day, 5 day/week during backfill.
Air monitoring	week	$1,190		1 technician, 10 hr/day, 5 day/week during excavation and backfill. Air monitoring to meet BAAQMD requirements
Archaeology monitoring	week	$4,760		1 archaeologist, 8 hr/day, 5 day/week throughout construction.
Construction Reporting				
Construction Completion Report -- Miscellaneous Small Chemical Spill Sites	ls	$50,000	Single remedial units or small chemical spill sites	Trust will request site certification in the Construction Completion Report. **(Trust experience; 2006)**
Construction Completion Report -- Large/Multiple Remedial Unit Chemical Spill Sites	ls	$150,000	Multiple remedial units or large chemical spill sites such as Bldg 1065 Area and Bldg 207/231 Area CAPs	Trust will request site certification in the Construction Completion Report. **(Trust experience; 2006)**
Construction Completion Report -- Multiple Chemical Spill Sites	ls	$300,000	Sites with 4 or more sites within a single construction effort such as BBDA 1, 1A, 2, 2A or RAP3 Area B sites.	Prorated to each site within the construction effort. **(Trust experience; 2006)**
Construction Management				
Engineering project management	%	10%	Of design and construction management services.	CCI factor of 1.26 applied for San Francisco, CA **(ENR CCI; RS Means EREM, Figures 63-64; 2006)**
Legal and administrative costs	%	5%	Of capital costs w/ contractor overhead and profit.	CCI factor of 1.26 applied for San Francisco, CA **(ENR CCI; RS Means EREM, Figures 63-64; 2006)**
Contingencies	%	20%	Of capital costs w/ legal and administrative costs.	CCI factor of 1.26 applied for San Francisco, CA **(ENR CCI; RS Means EREM, Figures 63-64; 2006)**

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
[F] LANDFILL SITES DESIGN AND CONSTRUCTION MANAGEMENT				
Planning, Remedial Design Implementation Documents				
Planning / Remedial Design	ls	$53,550	Typical. Request site-specific quote.	Includes orientation of engineering design firm, and preparation of H&S plan and remedial design work plan.
Prepare remedial design drawings	sheet	$8,000	Typical. Request site-specific quote.	Preparation of remedial design drawings, and revisions to incorporate comments from Trust, NPS, RAB, and regulatory agencies. **(Trust experience; 2006)**
Prepare remedial design reports	ls	$80,000 to $140,000	Typical. Request site-specific quote.	Preparation of remedial design work plan and specs, and revisions to incorporate comments from Trust, NPS, RAB, and regulatory agencies. **(Trust experience; 2006)**
Coordinate with waste management facilities	ls	$11,900	Typical. Request site-specific quote.	Coordination with waste management facilities prior to disposing waste.
Bid, award, and negotiate construction contract	ls	$29,750	Typical. Request site-specific quote.	Reproduction of bidding documents, bidding, and negotiation of contract.
Conduct surveying	acre	$1,785	Typical. Request site-specific quote.	Surveying is necessary for preparing plans and specifications.
Perform remedial design geotechnical study	ea	$47,600	Typical. Request site-specific quote.	Geotechnical investigations are necessary for preparing plans and specifications (e.g. soil properties, slope stability).
Perform remedial design investigation	ea	$77,350	Typical. Request site-specific quote.	Sampling is necessary to characterize boundaries, and further evaluate types and distributions of waste and soil in landfill.
Construction Observation				
Resident engineer / site supervisor	week	$5,950		1 engineer, 10 hr/day, 5 day/week throughout construction.
Field engineer to coordinate disposal issues	week	$5,950		1 engineer, 10 hr/day, 5 day/week throughout construction to
Engineering technician	week	$3,570		1 engineer, 4 hr/day, 5 day/week throughout construction.
Field administrative support	week	$2,380		1 engineer, 4 hr/day, 5 day/week throughout construction.
Field vehicles and equipment	week	$1,547		Vehicle, field supplies, photographs, OVM, and other H&S equipment.
Geotechnical and compaction testing	week	$3,868		1 technician, 10 hr/day, 5 day/week during backfill.
Air monitoring	week	$1,190		1 technician, 10 hr/day, 5 day/week during excavation and backfill. Air monitoring to meet BAAQMD requirements
Archaeology monitoring	week	$4,760		1 archaeologist, 8 hr/day, 5 day/week throughout construction.
Construction Reporting				
Prepare Construction Completion Report -- Single Landfills	ls	$150,000	Single Landfills or large fill sites such as Landfill E, Landfill 10, Landfill 8, Landfill 2, Fill Site 1.	**(Trust experience; 2006)**
Prepare Construction Completion Report -- Multiple Chemical Spill Sites	ls	$300,000	Sites with 4 or more sites within a single construction effort such as BBDA 1, 1A, 2, 2A or RAP3 Area B sites.	Prorated to each site within the construction effort. **(Trust experience; 2006)**
Prepare Site Certification Report	ls	$50,000	For CERCLA sites where post-construction monitoring is required (e.g. landfill clean closure / capping sites) per Consent Agreement with DTSC.	Based on actual costs for Crissy Field OU and DEH OU certification reports. **(Trust experience; 2006)**
Construction Management				
Engineering project management	%	10%	Of design and construction management services.	CCI factor of 1.26 applied for SF, CA **(ENR CCI; RS Means EREM, Fig 63-64; 2006)**
Legal and administrative costs	%	5%	Of capital costs w/ contractor overhead and profit.	CCI factor of 1.26 applied for SF, CA **(ENR CCI; RS Means EREM, Fig 63-64; 2006)**
Contingencies	%	20%	Of capital costs w/ legal and administrative costs.	CCI factor of 1.26 applied for SF, CA **(ENR CCI; RS Means EREM, Fig 63-64; 2006)**

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
[G] NON-LANDFILL SITES OPERATIONS AND MAINTENANCE				
ANNUAL COSTS				
Inspect and Maintain Cover				
Annualized Cost of 5-year Inspections & Repairs -- Small Remedial Unit or Site	ls	$500	Small remedial units or sites	Inspect cover and make needed repairs to cracks/seals, 1 technician, 1 day /yr. Summarize in letter report. **(ECHOS 33 08 05; 2006)**
Annualized Cost of 5-year Inspections & Repairs -- Multiple Remedial Units or Large Site	ls	$2,500	Multiple remedial units or large sites	Inspect cover and make needed repairs to cracks/seals, 1 technician, 1 day /yr. Summarize in letter report. **(ECHOS 33 08 05; 2006)**
Conduct Groundwater Monitoring				
Sample monitoring wells or seeps	ea	$268	Per sample location	1 geologist samples 5 wells in 10 hr day, plus $250 of materials
Dispose of groundwater sampling residuals	ea	$452	Per sample event	1 technician disposes of water from 4 wells in 8 hr day, plus equipment
Analyze sample, validate data, manage and enter in Trust database	ea	varies	SEE [B] SAMPLE ANALYSIS AND MANAGEMENT	
Prepare groundwater monitoring report	ea	$5,950		Quarterly, semiannual, or annual report summarizing groundwater elevation data, analytical results, and historic data tables; figures of sample locations and groundwater monitoring wells; and brief text identifying any variations from sampling plan.
Maintain Land Use Control / Notification (LUC/LUN) (Area A or Area B)			Sites on Area A / B boundary: Include costs for both Area A and Area B	
LUC Project Management/Administration				
Annual Administrative Cost of LUC/LUN	ls	$1,000	Small or large remedial units or sites, 30 years.	**(Trust experience; 2005)**
Annualized Cost of 5-year Review	ls	$2000 / $4000	Small / Multiple large remedial units or sites, 30 years.	**(Trust experience; 2005)**
Annual Cost Contingency				
Contingencies	%	20%	Of total annual operations and maintenance costs.	CCI factor of 1.26 applied for San Francisco, CA **(ENR CCI; RS Means EREM, Figures 63-64; 2006)**
TOTAL OPERATIONS AND MAINTENANCE COSTS				
Net Present Value (NPV) of Total Annual Costs	varies	2.5 - 3.0 %	Update rates yearly in January when published by Federal government. 3 Year O&M Duration = 2.5 % 7 Year O&M Duration = 2.7 % 10 Year O&M Duration = 2.8 % 20 Year O&M Duration = 3.0 % 30 Year O&M Duration = 3.0 %	Circular No. A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, Appendix C, President's Federal Office of Management and Budget **(OMB, January 2006)** (www.whitehouse.gov).

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
[H] LANDFILL SITES OPERATIONS AND MAINTENANCE				
PREPARE LANDFILL OPERATIONS & MAINTENANCE REPORTS & CONDUCT SURVEYS				**(Landfills 8 & 10 FS; EKI, 2005)**
Perform additional geotechnical study - mechanical stabilization	ea	$15,000	Typical. Request site-specific quote.	3 broings at Landfill 10 toe (mech. stab. alts. only). Golder project experience.
Perform geotechnical study - landfill slopes	ea	$45,000	Typical. Request site-specific quote.	EKI project experience. Landfill 10 specific.
Perform additional geotechnical study - finite element for pin piles	ea	$75,000	Typical. Request site-specific quote.	Finite element analysis for pin piles. Golder project experience. Landfill 10 specific.
Perform geotechnical study - top of landfill	ea	$45,000	Typical. Request site-specific quote.	EKI project experience. Landfill 10 specific.
Identify landfill edges	ea	$30,000	Typical. Request site-specific quote.	Trenching is necessary to characterize boundaries under the non-consolidation alternatives.
Prepare landfill gas treatment system design	ls	$50,000	Typical. Request site-specific quote.	Preperation of landfill gas treatment system. for alternatives with geomembrane.
Prepare Construction Quality Assurance Plan - Excavation Alternative	ls	$20,000	Typical. Request site-specific quote.	Prepare CQAP for excavation alternatives.
Prepare Construction Quality Assurance Plan - Cover Alternative	ls	$30,000	Typical. Request site-specific quote.	Prepare CQAP for cover alternatives (includes demonstration/test).
Prepare Operation and Maintenance Plan	ls	$15,000	Typical. Request site-specific quote.	Maintenance Plan for maintaining installed covers.
INSPECT, REPAIR, MAINTAIN COVER, LANDFILL GAS, GROUNDWATER COLLECTION SYSTEMS				
			Typical. Request site-specific quote.	**(Landfills 8 & 10 FS; EKI, 2005)**
Perform topographic survey to monitor settling every 5 years	acre	$300		$1,500/acre every 5 years or equivalent annual cost of $300/yr. Golder project experience.
Repair damage to permeable cover caused by subsidence or erosion	ls	$3,100		Annual repairs, 2 technicians, 20 hr each/yr, plus $500 materials.
Repair damage to low-permeability cover caused by subsidence or erosion	ls	$3,600		Annual repairs, 2 technicians, 20 hr each/yr, plus $1,000 materials
Repair periodic breaches to cover	ls	$4,000		$25,000 to repair significant breaches of cover system every 5 years, or equivalent annual cost of $4,000 per year. EKI project experience.
Inspect and repair passive gas system	ls	$2,600		Annual repairs, 2 technicians, 20 hr each/yr.
Inspect and clear vegetation from drainage ditches	ls	$2,000		1 technician, 8 hr/day, 4 day/yr.
Conduct Groundwater Monitoring	ls	varies	SEE [B] SAMPLE ANALYSIS AND DATA MANAGEMENT SEE [G] OPERATIONS AND MAINTENANCE	
Prepare groundwater monitoring reports	ea	$5,000		Quarterly, semiannual, or annual report summarizing groundwater elevation data, analytical results, and historic data tables; figures of sample locations and groundwater monitoring wells; and brief text identifying any variations from sampling plan.
Operate Groundwater Extraction System				
Electrical costs	ls	$200		Pumps operate 50% of time, $0.10/kwhr
Maintenance	ls	$2,000		1 technician, 8 hr/day, 4 day/yr.
Conduct Monitoring for NPDES Permit or Sanitary Sewer Discharge				
Prepare quarterly monitoring reports	ea	$1,000	Typical. Request site-specific quote.	Quarterly report summarizing surface water discharge data.
Sanitary sewer discharge fee	ls	$52,000		Fee of $4.1054/100 ft3 of discharge. Assessed discharge consists of 75% of the annual precipitation in drainage area of Landfill E, which is assumed to be captured in subsurface drains.
Prepare sanitary sewer discharge report	ls	$1,500		Fee of $4.1054/100 ft3 of discharge. Assessed discharge assumes that groundwater is removed at Sewer Lift Station No. 1 or Nike Facility at a rate of 1 gallon per minute and extraction well operates 50% of the time.

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
Conduct Landfill Gas Monitoring			Typical. Request site-specific quote.	
Test with LEL monitor for methane content and collect landfill gas samples	ea	$380		Golder project experience.
Laboratory analytical services				
Volatile organic compounds (EPA Method TO-14)	ea	$311		Tedlar bag collection, K-Prime Analytical quotation.
Fixed gases (O_2, N_2, CO_2) and methane	ea	$133		Tedlar bag collection, K-Prime Analytical quotation.
Prepare landfill gas report	ls	$10,000		Golder project experience.
Conduct Biological Survivorship Monitoring				
Field inspection of biota	ea	$200		2 biologists, 8 hr/day, 4 day/yr. Inspections to observe and count surviving species.
Prepare landfill gas report	ls	$11,900		Golder project experience.
Geotechnical Stabilization				
Install drainage piping within buttress	ft	$2		4" perforated drain piping, through buttress, on 5' centers, Means 02620-265 0040
Import structural backfill material (purchase and transport)	cy	$18		Standard backfill material less place and compaction
Mix and place soil buttress	cy	$5		Same cost as place and compact stockpiled fill.
Stabilize Soil Using Pin Piles				
Mobilized pin pile installation equipment	ls	$15,000		Golder estimate, based on project experience. Landfill 10 specific.
Construct and remove working pads for pin pile installation	ls	$23,000		Golder estimate, based on project experience. Landfill 10 specific.
Install pin piles	ft	$96		Includes material and allowance for refusal. Golder estimate, based on project experience.
Install Vegetative Cover			Typical. Request site-specific quote.	
Purchase and install root barrier geomembrane	sf	$1		40 mil HDPE/LLPE geomembrane Golder project experience.
Import and place onsite dune sand	cy	$10	Consult Trust on availability and location.	Purchase plus load and transport of dune sand from Trust stockpile area.
Install Low-Permeability Cover				
Grade and compact 2-ft cover foundation layer to 90% compaction	cy	$5		200hp bulldozer, Means 02315-410-4040; and $0.80 for Vibrating roller, 12" lifts compactor, Means 02300-300-6270.
Repair damage to cover with geomembrane caused by subsidence or erosion	acre	$5,058		Annual repairs, 2 technicians, 40 hours/year, plus $2,250 in materials for 2-acre landfill.
Constuct Landfill Gas Control and Monitoring System			Typical. Request site-specific quote.	
Install landfill gas biofiltration treatment system	ls	$60,000		Landfill gas treatment (if final design confirms required). Golder project experience.
Install Veneer Reinforcement				
Purchase and install low tensile strength geogrid	sf	$1		Based on one layer of geogrid. Golder project experience.
Purchase and install low to medium tensil strength geogrid	sf	$1		Based on one layer of geogrid. Golder project experience.
Purchase and install medium tensile strength geogrid	sf	$1		Based on one layer of geogrid. Golder project experience.
Purchase and install medium to high tensile strenght geogrid	sf	$2		Based on up to two layers of geogrid. Golder project experience.
Purchase and install high tensile strength geogrid	sf	$2		Based on up to two layers of geogrid. Golder project experience.
Restore Paved Areas			Typical. Request site-specific quote.	
Construct curb and gutter/drainage system	ft	$35		EKI experience, including provision for surface flow diversion. Landfill 10 specific.
Connect new storm drain to existing storm drain system	ft	$100		$10/in/ft, for 10" diameter pipe. Landfill 10 specific. Golder project experience.
Import, place, and compact 8 feet of crushed concrete as backfill	cy	$3	.	Crushed concrete from onsite demolition

UNIT COSTS MASTER REFERENCE TABLE
Presidio of San Francisco, California

TASK DESCRIPTION	UNIT	UNIT COST	COMMENTS ON APPLICATION	ASSUMPTIONS
Maintain Land Use Control / Notification (LUC/LUN) (Area A or Area B)			Sites on Area A / B boundary: Include costs for both Area A and Area B	
LUC Project Management/Administration				
Annual Administrative Cost of LUC/LUN	ls	$1,000	30 years.	**(Trust experience; 2005)**
Annualized Cost of 5-year Review	ls	$5,000	30 years.	**(Trust experience; 2005)**
Annual Cost Contingency				
Contingencies	%	20%	Of total annual operations and maintenance costs.	CCI factor of 1.26 applied for San Francisco, CA **(ENR CCI; RS Means EREM, Figs 63-64; 2006)**
TOTAL OPERATIONS AND MAINTENANCE COSTS				
Net Present Value (NPV) of Total Annual Costs	varies	2.5 - 3.0 %	Update rates yearly in January when published by Federal government. 3 Year O&M Duration = 2.5 % 7 Year O&M Duration = 2.7 % 10 Year O&M Duration = 2.8 % 20 Year O&M Duration = 3.0 % 30 Year O&M Duration = 3.0 %	Circular No. A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. Appendix C, President's Federal Office of Management and Budget **(OMB, January 2006)** (www.whitehouse.gov).

APPENDIX C

RESPONSIVENESS SUMMARY — COMMENTS AND RESPONSES

~~(FINAL VERSION ONLY)~~

Response to Comments on the
Draft Corrective Action Plan
Building 207/231 Area, Presidio of San Francisco
San Francisco, California; July 2005

Comments from the Regional Water Quality Control Board (RWQCB) letter dated June 15, 2006:

We reviewed the D*raft Corrective Action Plan for Building 207/231 Area, Presidio Trust of San Francisco* (Draft CAP) dated July 2005, and the Trust Meeting Notes prepared by MACTEC Engineering and Consulting, Inc. based on our technical meeting on May 10, 2006. We provided our comments on the Draft CAP at this meeting. The Meeting Notes submitted by you on May 18, 2004 via e-mail are attached. We concur with the Meeting Notes and these Notes serve as our official comments on the Draft CAP.

In addition to the comments detailed in the Meeting Notes, we have a few additional comments:

Comment: **Page 64, Soil detection is show as *µg/L*, should this be *mg/Kg*?**

Response: The correct units are mg/kg; the Draft Final CAP has been revised as indicated.

Comment: **Page 131, Section 6.2 – "Sidewalls will be sampled at the midpoint of the excavation's height … per excavation sidewall". Please add the following language "(using best professional judgment for biasing sample location to any visibly stained soils layers)" after the word "height".**

Response: The Draft Final CAP text has been revised as indicated.

Comment: **Plate 21 and Table 7:**

Install a new well either at the existing well location 207GW03 or to the north of Mason Street.

Recommend moving New Well #2 to the west.

Recommend keeping the monitoring well 231GW16 (change from red to blue) as an up-gradient well to Building 207 Remedial Unit using it as the Pre-Construction Monitoring Well instead of 231GW13.

Response: The Draft Final CAP text, Table 7, and Plate 21 have been revised as indicated.

General Comments from Meeting Notes dated May 18, 2006 from May 10, 2006 Technical Meeting:

Comment 1: **Revise typographical errors and make suggested wording and format changes, round soil volumes to 2 significant figures, check accuracy of soil and groundwater concentration units in text and on plates.**

Response 1: Trust concurs. The Draft Final CAP has been revised globally as indicated to address errors and suggested wording changes.

Comment 2: **Of the 3 Backfill Options (A = Open, B = Partial, C = Complete) to be considered in remedial design, selected option must be adequate to prevent free groundwater from being left exposed. Therefore, Option A (Open) would not be acceptable to RWQCB and would trigger surface water standards.**

Response 2: Trust concurs that Option A (Open) is least desirable option considered, and does not anticipate compelling reasons for selecting this option for implementation at any of the remedial units. Trust plans to convert area within blue zone shown on Plate 21 to a vegetated wetland system with no sustained expression of groundwater.

Trust has a general preference for Option B (Partial) in these areas because: (1) Considerable value in conducting Vegetative “Pilot Study” under Vegetation Management Plan (VMP) in intermixed freshwater/marsh, groundwater, saltwater/tidal influence areas; (2) Would visually serve to acclimate the public to appearance of vegetation and standing water in this area that will eventually be restored to wetlands.

Trust anticipates Option C (Complete) will only be selected for remedial units (or portions thereof) that are smaller or adjacent to buildings, within active parking lots or structures (e.g., Building 230 Area Soil Remedial Unit [RU]).

Trust to address in remedial design for each remedial unit in conjunction with Trust’s Cultural and Natural Resources Management Program & VMP. Trust remedial design will not present an Option A backfill scenario that allows sustained expression of contaminated groundwater.

Comment 3: **In excavation areas that are limited due to presence of permanent structures (e.g., Building 230), if significant contamination is left in place under an LUC (with or without ORC injection, would need to safeguard against seepage into adjacent areas, e.g., by installing a liner/barrier.**

Response 3: Trust concurs. Trust to address as contingency (a) in remedial design, and (b) if post-corrective action monitoring indicates necessary with RWQCB input and approval.

Specific Comments

Comment 4: **pages xxv; xxvii / Executive Summary—Recommended Corrective Action Alternatives:**

Provide additional detail on ORC application, assessment, duration, monitoring. Groundwater monitoring assumptions for costing purposes are important.

Response 4: Trust concurs. The Draft Final CAP has been revised as indicated to provide additional details on assumptions for ORC application. Trust has outlined monitoring criteria and reasonable costing assumptions in the CAP, and acknowledges that actual costs may differ from those assumed.

Comment 5: pages 60-66 / Sections 3.4.7-3.4.12—Source, Nature, and Extent of Chemicals in Soil and Groundwater:

Reference report where data is presented if boring locations cited are not shown on plates.

Response 5: Trust concurs. The Draft Final CAP has been revised as indicated.

Comment 6: page 61 / Section 3.4.8; Building 230:

Revise discussion of contamination decreasing with depth as it relates to specific COCs.

Response 6: Trust concurs. The Draft Final CAP has been revised as indicated.

Comment 7: page 64 / Section 3.4.11; Building 207 UST Area:

Clarify most exceedances are due to current screening levels being lower than those applied during UST excavations.

Revise reference to Plate 11a regarding borings where petroleum was not detected.

Response 7: Trust concurs. The Draft Final CAP has been revised as indicated.

Comment 8: page 67 / Section 3.4.13—Site Conceptual Model:

Clarify most exceedances in Building 207 area occur outside footprint of previous excavations where not all contamination above cleanup levels was removed.

Response 8: Trust concurs. The Draft Final CAP has been revised as indicated.

Comment 9: page 77 / Section 4.3.2—Chemicals of Concern in Groundwater:

Text reference to Plates 18a and 18b that all COCs above cleanup levels are shown may be inaccurate; not all data may be shown.

Response 9: Plates 18a, 18b, 19a, and 19b have been revised to include data from the Former Building 271 Area.

Comment 10: **page 78 / Section 4.4—Identification of Remedial Units:**

Building 230 Area remedial unit is not well defined along railroad tracks. Activities along tracks may have released sources of contamination; additional sampling would provide more data on nature and extent of contamination.

Response 10: Trust concurs. The Draft Final CAP has been revised to include new soil sample data obtained during the geoarchaeological study, and to clarify approximate limitations on extent of over-excavation at the Building 230 Area remedial unit based on confirmation sampling as follows:

- Along railroad tracks (north-south) until cleanup levels are met.
- Toward Building 230 (west) under elevated loading dock if structural integrity is not compromised
- Toward parking lot (east) fill area just to Building 207/231 Area site boundary

Excavation at this RU would be backfilled under Option C (Complete) under current plans for building to be at its current location during Building 230 RU excavation work. If the building is moved or demolished prior to the Building 230 RU excavation work, then Option B backfill may be considered. The Draft Final CAP states that any contamination that could not be accessed with the building in place during corrective actions would be addressed at the time the building is demolished.

Comment 11: **page 78-79 / Section 4.4; Building 271 (and p. xvi of Executive Summary):**

Clarification is needed on why a RU was not identified, and how to address cleanup level exceedances for this former garage area.

Response 11: The Draft Final CAP text and plates have been revised to indicate a separate remedial unit was not developed for this area because exceedances were in one sample, suspected to be fill- rather than petroleum-related, and not significantly above cleanup levels. However, the Draft Final CAP has been revised to include this area with the Building 231 Area remedial unit, for which the corrective action alternative defers excavation of these areas to future implementation by CalTrans as part of the Doyle Drive replacement project.

Comment 12: **page 89 / Section 5.1.2—Identification and Screening of Potential Remedial Technologies:**

Is discussion explaining why remedial technologies were not evaluated further for isolated occurrences of metals in soil and groundwater (e.g., low migration/groundwater contamination potential) valid programmatically for Presidio?

Response 12: DTSC and Trust confirmed validity. The Draft Final CAP has been revised to incorporate results of the Arsenic in Groundwater Evaluation Technical

Memorandum related to monitoring for arsenic. The results of the recent Subsurface Geoarchaeological Survey conducted at the site have also been incorporated in the Draft Final CAP.

Comment 13: **page 90 / Section 5.1.2.2—Land Use Controls:**

Discussion of remedial units occurring within Area B of the Presidio should be clarified and refer to a plate revised to show Areas A and B.

Response 13: Trust concurs. The Draft Final CAP has been revised as indicated, and Plate 1 has been revised to show the boundary of Area A and Area B.

Comment 14: **page 105 / Section 5.2—Corrective Action Alternatives Considered:**

Capping/Land Use Controls discussion (and other relevant sections) should clarify (1) groundwater monitoring cessation after cleanup levels are met, and (2) well abandonment, would be implemented upon regulatory agency approval.

Response 14: Trust concurs. The Draft Final CAP has been revised as indicated. References to agency-approved deviations from well abandonment regulations (neat bentonite instead of concrete) have been added to Section 6.0—Implementation of Corrective Action Alternatives, and other relevant sections of the report.

Comment 15: **page 122 / Section 5.4.3—Alternative 3: Excavation, Offsite Disposal of Soil, and Groundwater Monitoring:**

Discussion of groundwater monitoring locations should be clarified to indicate they are not just downgradient wells, and reference Plate 21 and Table 7 that show and describe proposed locations.

Response 15: Trust concurs. The Draft Final CAP has been revised as indicated.

Comment 16: **page 137 / Section 6.5—Groundwater Monitoring; Plate 21; Table 7:**

Plate 21 and Table 7 that show and describe 5 new proposed monitoring well locations should be revised to provide a more hydrologically effective ground water monitoring network downgradient of both the 207 and 231 RUs.

Response 16: The Draft Final CAP text, Table 7, and Plate 21 have been revised to indicate the purpose and location of 6 Proposed New Wells to provide a more hydrologically effective ground water monitoring network downgradient of both the 207 and 231 RUs.

Comment 17: **page 137 / Section 6.5—Groundwater Monitoring; Plate 21; Table 7:**

Were there detections of arsenic in intermediate wells in Building 231 Area that are being abandoned?

Response 17: The intermediate wells that have had arsenic detections above cleanup levels are included in the monitoring program as shown on Plate 21 and described in Table 7.

Comment 18: **page 139 / Section 6.5—Groundwater Monitoring:**

Last two paragraphs of section should be revised to clarify the frequency of proposed groundwater monitoring and reference Table 7.

Response 18: Trust concurs. The Draft Final CAP has been revised as indicated.

Comment 19: **page 139 / Section 6.6—Implementation Schedule:**

Text and Table 7 should indicate start of construction is contingent on RWQCB approval of CAP work plan, and anticipated dates should be updated

Response 19: Trust concurs. The Draft Final CAP has been revised as indicated.

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Building 207/231 Area
Presidio of San Francisco
San Francisco, California

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Building 207/231 Area
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